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MECHANICAL ENGINEERING

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Hydroelectric Installation on the Kern River By E. C. Hutchinson

The Moody Ejector Turbine, By S. Logan Kerr

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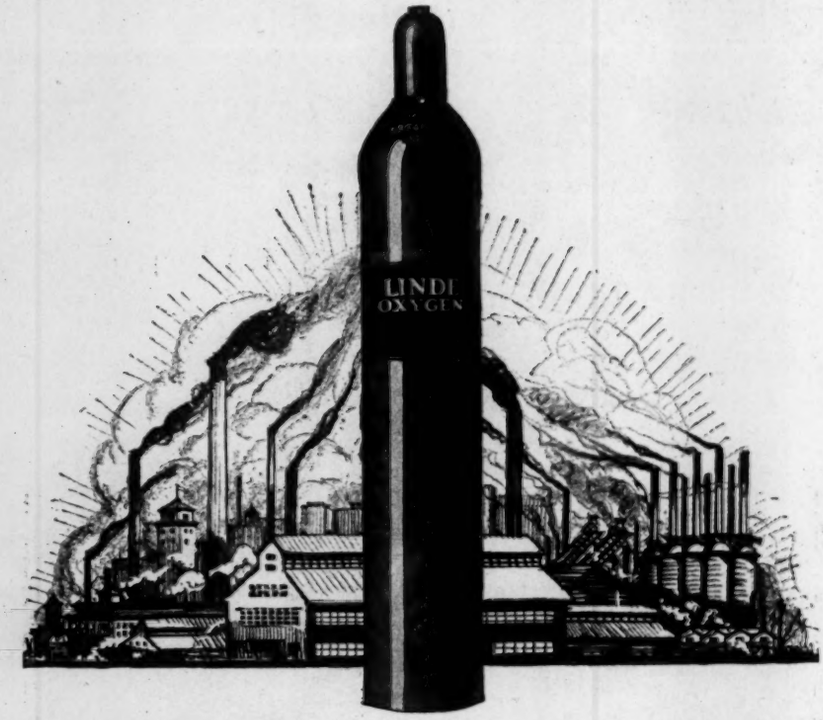

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Mechanical Engineering

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Contributors and Contributions

The Strength of Welded Pressure Vessels

R. J. Roark

The recent activity of the A.S.M.E. Boiler Code Committee in developing a Code for Air Tanks and Pressure Vessels has aroused great interest in the strength of welded joints when used with such containers. The paper on Strength of Mechanically Welded Pressure Containers, appearing in this issue of Mechanical Engineering, is to be presented at the A.S.M.E. Spring Meeting in Atlanta as one of several papers which will bring definite information to this controversy on welded joints. R. J. Roark, Assistant Professor of Mechanics at the University of Wisconsin, the author of this paper, is a graduate of the University of Illinois in the class of 1911, receiving his degree of Master of Science in 1912. After some experience in designing reinforced concrete, he went to the University of Wisconsin as instructor in Mechanics. In 1917 he entered military service and became an instructing officer in the field artillery school at Saumur, France, serving later with the First Division. Upon his discharge, Mr. Roark was engaged in drafting the Engineering Council law for licensing engineers. After a year as associate professor of Mechanics and Hydraulics at the University of Iowa, Mr. Roark took up his present position in 1920.

Cotton-Ginning Machinery

The paper by S. E. Gillespie on Cotton-Ginning Machinery will be presented at one of the joint sessions to be held by the Textile and Machine Shop Divisions at the Atlanta Spring Meeting of the A.S.M.E. Mr. Gillespie's paper treats of the development of the cotton gin and points out the various mechanical requirements of the cotton ginning process. Mr. Gillespie graduated from the A. & M. College of Texas in 1903. Since that time he has been engaged mainly in the design of textile machinery and buildings and the supervision of construction. Mr. Gillespie is at present mechanical and industrial engineer with the Engineering Service Company of Dallas, Texas.

Fuel Wastes in the Steel Industry

The A.S.M.E. Spring Meeting paper by F. G. Cutler on Reduction of Fuel Wastes in the Steel Industry, given in this issue, will be presented at the Fuels Session. Mr. Cutler discusses the economy of blast furnace gas in reducing fuel wastes. Mr. Cutler who is at present Chief of the Bureau of Steam Engineering in the Tennessee Coal, Iron and Railroad Company, graduated from Kentucky State University in 1901. He received his degree as M.E. in 1904. For five years he served as Assistant in the Steam Engineering Department of the Illinois Steel Company in Chicago and in 1906 he came to the Tennessee Coal, Iron and Railroad Company to take charge of the Steam Engineering Department of the Ensley Division. In April, 1914 he was promoted to his present position.

Kern River Hydroelectric Installation

E. C. Hutchinson

The paper by Ely C. Hutchinson of San Francisco, describes the outstanding features of the hydroelectric installation in the Kern River No. 3 Plant of the Southern California Edison Company, in many respects a notable installation. This paper was presented before the March 23rd meeting of the San Francisco Local Section. Mr. Hutchinson received his early experience in the shop of the Union Iron Works where he was engaged in the design of stamp mills, steam and electric hoists, mining machinery, etc. From 1902 to 1907 he was in charge of design and installation of mining machinery for various companies on the Pacific coast. In 1908 he joined the Pelton Water Wheel Company as commercial engineer and he has successively held the positions of sales manager, engineering manager, and chief engineer. Mr. Hutchinson is at present Vice-President and General Manager of the Pelton Water Wheel Company.

The Ejector Turbine

The paper on the Moody Ejector Turbine by S. Logan Kerr received the A.S.M.E. Junior Prize for the year 1921. This paper is based on Mr. Kerr's thesis submitted in June, 1921, to the University of Pennsylvania. It includes a discussion of the operation problems of low-head hydroelectric power plants during flood periods. There is a description of the ejector turbine developed to offset these difficulties, and test results on experimental units. Upon his graduation from the University of Pennsylvania, Mr. Kerr entered the employ of the I. P. Morris Department of the William Cramp & Sons Ship & Engine Building Company, as research assistant.

Muscle Shoals

Colonel J. W. Joyes of the Ordnance Department, U. S. Army, was intimately connected with the planning and construction of the work at Muscle Shoals. In view of the present situation regarding the disposition of this remarkable war plant, his editorial on the engineering resources and possibilities of Muscle Shoals has great interest.

A.S.M.E. Spring Meeting, Atlanta, May 8-11

Information about technical program is provided in the Semi-monthly issues of the A.S.M.E. NEWS.

In connection with the Spring Meeting, Sessions and excursions will be held on May 5 and 6 at Charlotteville, Va., on May 12 at Birmingham, Ala.; Greenville, S. C., and Pensacola, Fla. and on May 13 at Muscle Shoals, Ala.

MECHANICAL ENGINEERING

Volume 44 April, 1922 Number 4

The Strength of Mechanically Welded Pressure Containers

By R. J. ROARK,[1] MADISON, WIS.

This paper describes pressure tests made on electrically welded, gas-welded, and riveted pressure containers, and tension and shear tests made on specimens cut from such containers and on specially prepared specimens of welded metal. The tests were made for the Vilter Manufacturing Company of Milwaukee, Wis., and had for their purpose the demonstrating of the strength and uniformity of construction in which the electric weld is employed.

The results of the tests indicate that in containers of the type studied, electrically welded head joints are sufficiently strong to develop the full strength of the shell and heads; that it is practicable to make electrically welded joints which are uniform in respect to tensile strength, shearing strength and structure of fused metal; that for the particular combination of metals tested, the tensile strength of such welded joints is about 28,500 lb. per sq. in. and the shearing strength about 25,500 lb. per sq. in.; that for the combination tested, the metal in the weld is less strong and less ductile than either the base metal or the filling metal before fusion; that the electrically welded joints tested were stronger in shear but weaker in eccentric tension than the riveted joints tested.

THE investigation which forms the subject of this paper was made by the writer for the Vilter Manufacturing Company of Milwaukee, who furnished all test specimens. The tests on the containers were carried out at the works of the company. The tests on the specimens cut from the containers and on the specially prepared specimens were made in the Materials Testing Laboratory of the University of Wisconsin.

The writer wishes to acknowledge the helpful coöperation of the officers of the Vilter Manufacturing Company, their readiness to submit their product to any test suggested and their promptness in furnishing the necessary specimens and appliances. Thanks are due for helpful suggestions to Prof. G. L. Larson, Professor of Steam and Gas Engineering at the University of Wisconsin, who witnessed the test on containers.

Purpose and Scope of the Investigation

The primary purpose of this investigation was to demonstrate the strength and uniformity of a certain type of commercial pressure container with electrically welded head joints. These containers were made of lap-welded pipe and were provided with spherical flanged heads. Their dimensions are given in Fig. 1. The average physical and chemical properties of the steel used, as reported by the company furnishing it, were as follows: Yield point, 38,000; ultimate, 64,000; elongation, 27 per cent; carbon, 0.17 per cent; manganese, 0.44 per cent; phosphorus, 0.010 per cent; sulphur, 0.027 per cent. It was proposed to determine the absolute strength of such containers by pressure tests on representative samples and to establish a comparison with vessels of like form and dimensions, but with gas-welded and riveted heads, by similar tests on such containers. In order to secure a more positive check on the uniformity of the joints and more specific information as to their strength under various conditions of stress, it was planned to cut from the containers specimens of such form as to give, when subjected to laboratory tests, the desired information. Partly to determine the best form for such specimens and the best method of testing them, and partly to aid in the interpretation of results, strain measurements were made on certain of the specimens during the tests. From these measurements relations were established between the internal pressure in a vessel of the standard type and the resulting stresses on the head joint.

In order to gain still more detailed information concerning the physical properties of welded joints, various special specimens of welded metal were made up and tested as subsequently described.

It is thus seen that the investigation comprised three more or less distinct series of tests, namely, tests on containers, tests on specimens cut from containers and tests on special specimens of welded metal.

Tests on Containers

In all, nine containers were tested. In each case, the tests consisted of subjecting the specimen to an internal hydraulic pressure which was gradually increased until rupture resulted or such rapid leakage developed as to make further increase of pressure impracticable. Pressure was in most cases applied in predetermined increments by a hand pump, and was measured by an indicating gage which had been calibrated immediately before its use in these tests.

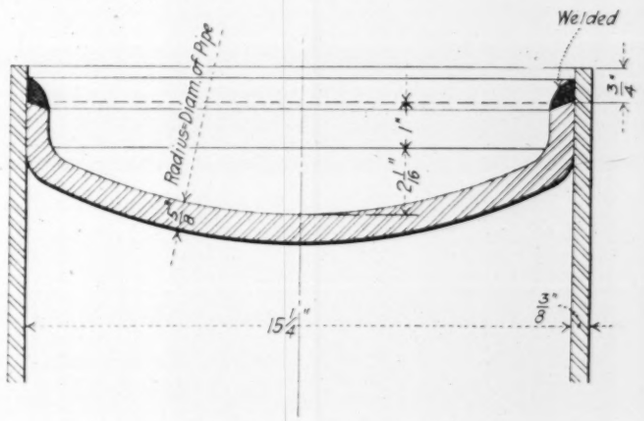

Fig. 1 Shape and Dimensions of Specimen Containers

Some of the specimens were of standard design. Some were so made as to secure failure of a particular sort, in order to provide information on some specific point. In order to compare the work of different operators, two similar gas-welded specimens were made up, the welds being made by different operators. On certain of the containers of standard design, strain measurements were made as mentioned above.

A few of the tests described separately below and a summary of the complete results obtained, is presented in Table 1. Accompanying photographs show the appearance of some specimens after testing, and indicate the manner of failure.

Specimen No. 1 was subjected to successive pressures of 200, 400, 800, 1200, 1600 and 1750 lb. per sq. in. Strain measurements were taken at each pressure which was then reduced to zero. The maximum pressure was then applied. At a pressure of 1750 lb. per sq. in. the coupling started to leak. The tank had visibly increased in diameter and the elastic limit had evidently been

[1] Asst. Prof. Mechanics, University of Wisconsin.

Abstract of paper for presentation at the Spring Meeting, Atlanta, Ga. May 8 to 11, 1922 of The American Society of Mechanical Engineers. Copies of the complete paper may be obtained gratis upon request. All papers are subject to revision.

exceeded. At a pressure of 1925 lb. per sq. in. leakage occurred at the weld of the nipple. A new nipple was welded on and the pressure increased to 2150 lb. per sq. in., when the specimen ruptured. Failure was due to circumferential tension in the shell. The heads did not reverse. (Fig. 2.)

Successive pressures of 500, 1000, 1500 and 1800 lb. per sq. in. were applied to specimen No. 2. Strain measurements were made at each pressure up to and including 1500 lb. The pressure was not reduced to zero after each application but was maintained and increased to the maximum without release. No leakage developed, but at a pressure of 2150 lb. per sq. in. one head reversed. At a

FIG. 2 SPECIMEN NO. 1 (ELECTRICALLY WELDED), SHOWING FRACTURE AFTER TESTING

pressure of 2200 lb. per sq. in. the specimen ruptured and the reversed head was violently forced off. Failure was due to combined longitudinal tension and bending, a crack in the outside face of the welded metal, indicating a local failure due to bending. (Fig. 3.)

In testing specimen No. 3, successive pressures of 200, 400, 800,

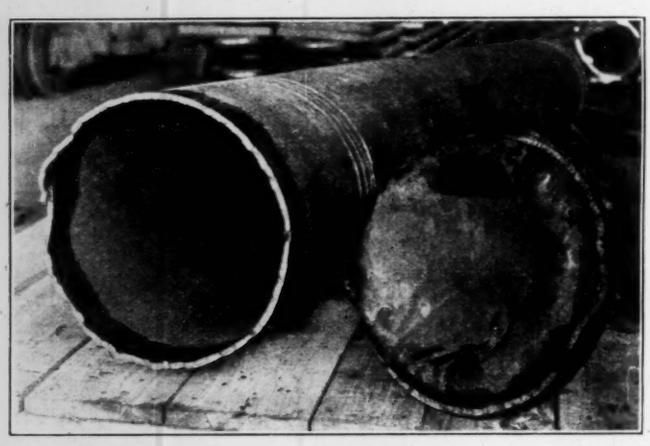

FIG. 3 SPECIMEN NO. 2 (GAS WELDED) SHOWING FRACTURE AND INNER SIDE OF REVERSED HEAD

1200, 1600, and 1800 lb. per sq. in. were applied. Strain measurements were made at each pressure before being reduced to zero. The maximum pressure was applied by power on the second day of the test. At a pressure between 1200 and 1600 lb. per sq. in. leakage was observed at both ends next the rivets and in the weld at the nipple. The nipple was replaced and the test continued. When 1800 lb. per sq. in. was reached the leakage became so bad that it was impossible to increase the pressure further by hand. By means of a power pump a pressure of 2100 lb. per sq. in. was attained but leakage prevented further increase. The container did not rupture nor did the heads reverse.

The testing of specimens Nos. 4 and 5 offers an opportunity to compare the work of different gas-welding operators as the two containers were similar in design and dimensions but welded in different shops.

STRESS ON HEAD JOINTS

During the tests on specimens Nos. 1 and 2, strain measurements were made at sections distant 1 in., 2 in., 3 in., and 5 in. from the end. The measurement at the end was made on a diameter by means of a wire-wound dial reading to one ten-thousandth of an inch. The other measurements were made in one case by means of a Berry strain gage, on a 2 in. gage line, and in the other case by means of wires which encircled the container and which were provided at both ends with lugs, between which measurements could be made to one-thousandth of an inch by means of an ordinary micrometer. Owing to the danger of explosive failure, readings were taken only up to about three-fourths the computed bursting pressure.

From the measurement thus made the stress at each section was computed, employing as the value of the modulus of elasticity, 29,000,000 lb. per sq. in. The stress at each section was then expressed as a percentage of the stress which would exist in a similar cylinder having the same internal pressure and not subject to end restraints. By plotting for each section a diagram of stress against pressure up to the maximum pressure at which readings were taken, the probable stress at bursting pressure (taken for this purpose as 2000 lb. per sq. in.) was determined by extrapolation. A diagram was then plotted in which these stresses (expressed as percentages of the normal stress) were used as ordinates and distances from the end of the specimen to where these stresses occurred were used as abscissae. The resulting diagram is shown in Fig. 5. In this diagram a portion of the shell is shown with the radial forces which act upon it. The inward forces (shown acting down) consist of the radial components of the circumferential stresses, determined as explained above. The outward forces (shown acting up) consist of the uniform internal pressure, which of course extends only to the beginning of the weld. The portion of the shell shown is in equilibrium under these forces and the stresses acting, and by applying the appropriate conditions of equilibrium the stresses on each of the important sections A-A, B-B, and C-C, were determined. They are represented in Fig. 6, 7 and 8. In the determination of these stresses the bending moment and shear at the section where the circumferential stress becomes equal to the stress which would exist if there were no end restraint, are assumed to be zero. This is not strictly correct, but it is not believed that the assumption introduces a considerable error.

The stress on section C-C depends upon the tension in the band of welded metal (shown in dotted line), and as the section area of this band is non-uniform and difficult to determine, it is prob-

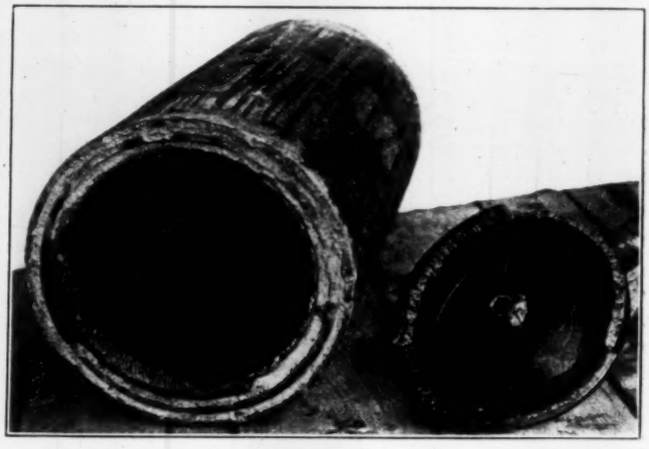

FIG. 4 SPECIMEN NO. 7 (REINFORCED ELECTRIC WELD) SHOWING FRACTURE AFTER TESTING

able that the stresses as computed for this section are more in error than the others. All of the results given are, to be regarded as approximations. They represent the nature of the stresses existing and the order of their magnitude, rather than their precise values. A rough check upon the correctness of these computed stresses is afforded by the manner in which the standard gas-welded container (specimen No. 2) failed and the pressure which caused rupture. This specimen failed on section B-B, and the form of fracture showed very clearly that the failure was principally due to flexure. The corrected pressure at rupture was 2090 lb. per sq. in. Using this as the value of P and computing the maxi-

mum fiber stress from the tension and moment indicated by Fig. 7 and the known thickness of the plate, a value of 77,000 lb. per sq. in. is obtained, which agrees very well with the modulus of rupture of the metal as determined by other tests. It will be noted that so far as conditions at the ends are concerned, section B-B is the weak point in the standard containers, as would be expected from the thinness of the metal there and the large bending moment, accompanied by direct tension. Section C-C appears to be the next weakest point. Local failure occurred on this section in specimen No. 2 and in the case of the reinforced specimen No. 7, (Fig. 4) about half the fracture was on section B-B and half on C-C. Apparently the surface of contact between the weld and the shell (section A-A) is stronger than either of the other two sections and in no case did failure take place on this section.

The values given for maximum shearing stress and maximum

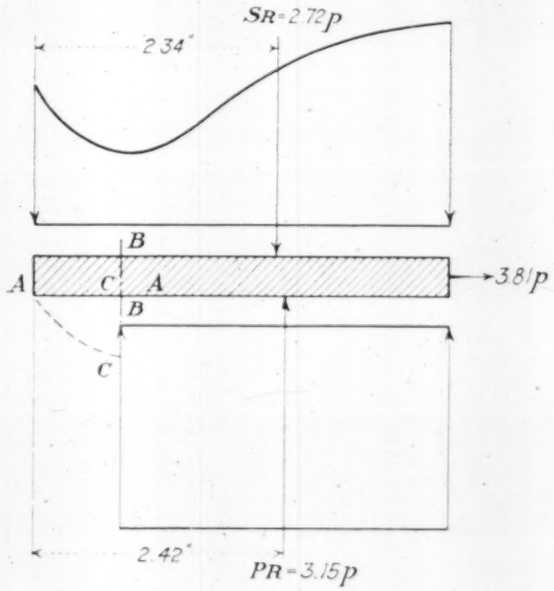

FIG. 5 STRESS, SHEAR AND MOMENT DIAGRAMS OF CONTAINER

tensile stress in Table 1 were computed for section A-A. It is to be noted that they do not represent the strength of the material in shear and tension, but simply the approximate shear and tensile stress produced in the welded joint by a pressure which caused failure at some other point.

In order to compare the stiffness and elasticity of the welded and riveted types of containers, measurements were made to determine the protrusion and permanent set induced in the heads of certain of the specimens by the pressures applied. These measurements, which were made on containers Nos. 1 and 3, were taken to the nearest one thousandth of an inch by means of Ames dials, readings being taken during the application of each pressure and after its release. The values given for protrusion and set represent respectively the total and the permanent displacement of the center of the head with respect to the end of the cylindrical shell. The data obtained from these measurements were used in plotting the curves of Fig. 9.

TESTS ON SPECIMENS CUT FROM CONTAINERS

It is apparent from the stresses represented in Figs. 6, 7 and 8 that the important stresses on the head joint are shear and tension, the latter being largely due to flexure. It appeared advisable therefore to cut from the containers specimens of such form as to

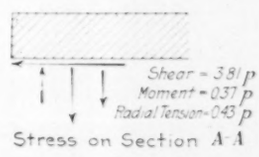

FIG. 6

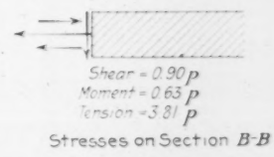

FIG. 7

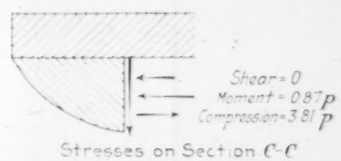

FIG. 8

FIGS. 6, 7 AND 8 STRESS, SHEAR AND MOMENT DIAGRAMS OF CONTAINER SECTIONS

make it possible to subject portions of the joint included therein to shear and flexure. Two forms of specimens were decided upon. Their form and part of the container from which they were cut are represented in Figs. 10, 11 and 12.

Specimens of Type A were tested in tension, the ends being held in wedge grips. The breaking load, eccentricity at rupture and manner of failure were noted. From the data thus obtained, the computed ultimate tensile stresses on the weld was determined. The results of these tests are tabulated in the complete paper while the appearance of the specimens before and after testing are shown in Figs. 13 and 17.

TABLE 1 RESULTS OF PRESSURE TEST ON CONTAINERS

Specimen Number	Description of Specimen	Pressure in Lb. per Sq. in. at First observed Leakage	Pressure in Lb. per Sq. in. at Disking of Heads	Pressure in Lb. per Sq. in. at Maximum	Method of Failure	Stresses on Head Joint at Maximum Pressure. Longitudinal shear lb. per linear inch of joint	Radial tension lb. per linear inch of joint	Bending moment inch-lb. per linear inch of joint	Max. resultant shearing stress lb. per sq. in.	Max. resultant tension stress lb. per sq. in.	Remarks
1	Standard commercial container with electrically welded heads, size 16 in. × 10 ft.	1925 (1820)		2150 (2040)	Longitudinal crack, started at nipple	7770	870	1780	9800	15000	
2	Standard type container with gas welded heads, size 16 in. × 10 ft.		2150 (2040)	2200 (2090)	Head forced off	7960	900	1820	10500	16000	Fracture on section B–B
3	Standard type container with riveted heads, size 16 in. × 10 ft.	1200 (1120)		2100 (2000)	Excessive Leakage						
4	Container with gas welded heads and gas welded longitudinal butt joints, size 16 in. × 10 ft. (weld by Le Quelle)			1600 (1540)	Split along long. butt weld						
5	Container with gas welded heads and gas welded longitudinal butt joints, size 16 in. × 10 ft. (weld by Vilter)			1300 (1240)	Split along long. butt weld						
6	Container with electrically welded heads and electrically welded longitudinal butt joints, size 16 in. × 10 ft.			1400 (1340)	Split along long. butt weld						
7	Reinforced container with electrically welded heads (3 concentric shells, concrete filled), size 10 in., 12 in., 14 in. × 3 ft. 2 in.		4500 4800	4800 (4680)	Head forced off	11860			18000		Fracture on sections B–B and C–C
8	Reinforced container with gas welded heads (3 concentric shells, concrete filled), size 10 in., 12 in., 14 in., × 3 ft. 2 in.	4350 (4230)	4100 (3980)	4350 (4230)	Excessive leakage at weld joints	10720					
9	Special container with one electrically welded; one head riveted, size 16 in. × 2 ft.	1750 (1670)		2500 (2390)	Split along lap weld	9100			11600	17600	

Specimens of Type B were tested in shear. The method of testing is shown by the photograph (Fig. 14) of the shear tool with specimen in place. This shear tool was designed to hold the specimen in such a position that the line of action of the applied load passed through the neutral axis of the section being tested. This necessitated inclining the plane of the section slightly and so introduced a small compression, but it eliminated the bending moment which would otherwise have existed. In general, the specimen failed to shear, as was intended, but in some cases it was found impossible to secure a shear failure, the adjacent metal crushing, tearing or bending before the weld gave way. A tabulation of the results secured from these tests is presented in the complete paper. The appearance of the specimens tested is shown in Fig. 15.

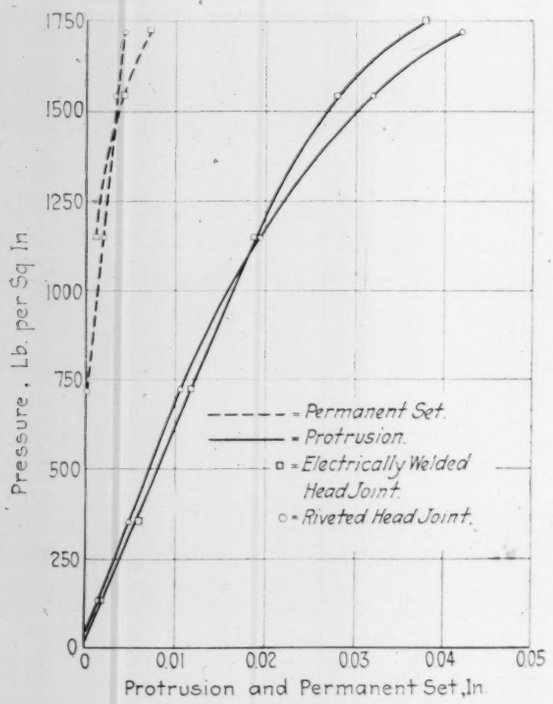

Fig. 9 Protrusion and Permanent Set of Container Heads at Different Pressures

Tests on Specially Prepared Specimens of Welded Metal

Two types of special specimens were tested. One was made by welding together a number of narrow strips of $^3/_8$-in. plate edge to edge and then cutting from the composite plate so formed a number of strips perpendicular to the welded joints. As eight strips were welded together each specimen had seven transverse welds in it. These specimens were tested in tension and the ultimate strength and per cent elongation noted. Eight specimens were thus made and tested, four having gas-welded joints and four having electrically welded joints. The results are presented in a table in the complete paper and the appearance of the specimens is shown by Fig. 16.

The other type of special specimen was made by welding together two $^3/_8$-in. plates edge to edge and cutting two pieces from the composite plate so formed, one along the center line of the weld and one from one of the plates, parallel to, but some distance away from the weld. Two sets of such specimens were prepared from plates electrically welded together and two sets from plates gas-welded together. One set of each kind was tested in tension, an extensometer being used and the proportional elastic limit, yield point, ultimate strength, modulus of elasticity, per cent elongation and per cent reduction of area determined. The results are tabulated in the complete paper while the stress strain diagrams are shown in Fig. 18.

TABLE 3 CHEMICAL CONSTITUTION OF SPECIAL SPECIMENS AND OF WELDING BARS
(Analyses by Robert W. Hunt Co.)

Specimen	Per cent Carbon	Per cent Manganese
Piece from center of electric weld	0.18	0.05
Piece from center of gas weld	0.06	0.08
Piece from plate remote from weld	0.12	0.51
Welding bar No. 1	0.07	0.12
Welding bar No. 2	0.07	0.05

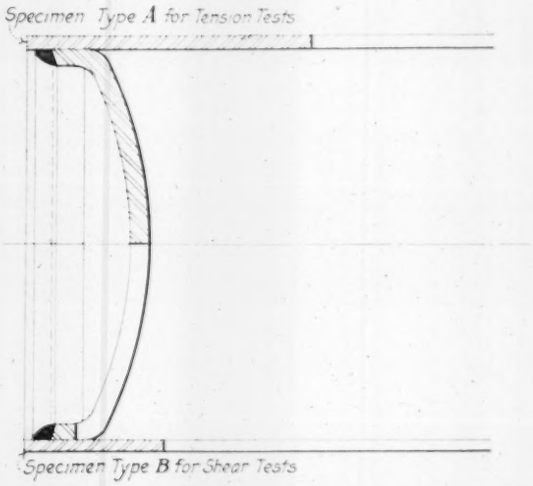

Fig. 10 Form of Specimens Subjected to Shear and Flexure

The remaining specimens were tested in shear. Two welding rods, similar to those used in making up the various containers and other welded specimens, were also tested in shear. The test consisted in subjecting the specimen to double shear while it was rigidly held in a special shear tool that prevented bending. The results of these tests are presented in Table 2.

Chemical analyses were made of each of the specimens of this type and of the two welding rods. The results are presented in Table 3.

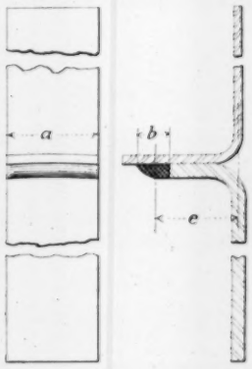

Fig. 11

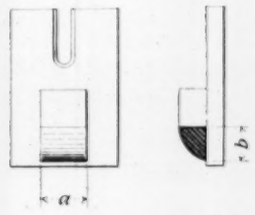

Fig. 12

Figs. 11 and 12 Sectional Diagrams of Specimens Subjected to Shear and Flexure

TABLE 2 TESTS OF SPECIAL SPECIMENS

Results of Shear Tests on Specimens cut Parallel to Welded Joints

Specimen No.	Location of Specimen	Dimension of cross section (in.)	Area cross section (sq. in.)	Load at failure in double shear (lb.) Load applied parallel to plane of joint 1	2	Load applied normal to plane of joint 1	2	Average of all tests	Average ultimate unit shearing stress (lb. per sq. in.)
1	Along center line of electric weld	0.265 × 0.254	0.0674	5840	5480	5300	5730	5740	42500
2	Along center line of gas weld	0.259 × 0.268	0.0694	6290	6410	6170	6400	6320	45500
3	In plate remote from weld	0.253 × 0.255	0.0645	7500	7500			7500	58100
4	Welding bar No. 1	0.186 Diam.	0.0272	2580				2580	47400
5	Welding bar No. 2	0.186 Diam.	0.0272	2600				2600	47800

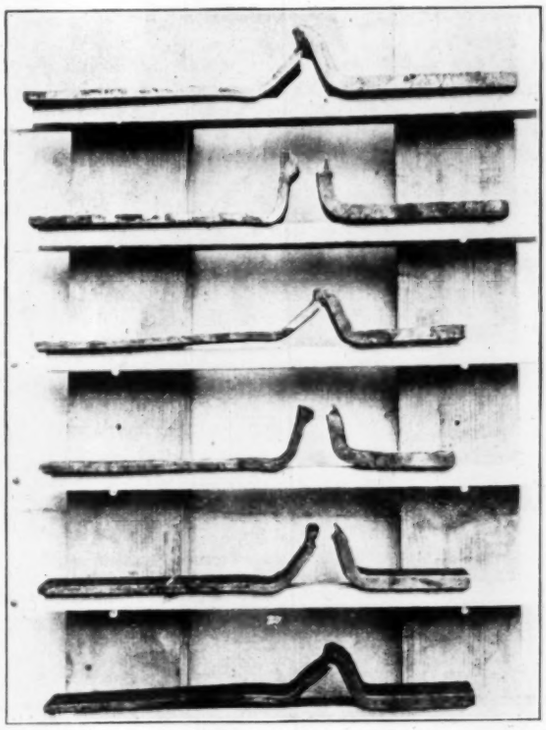

FIG. 13 SPECIMENS OF TYPE A, WELDED

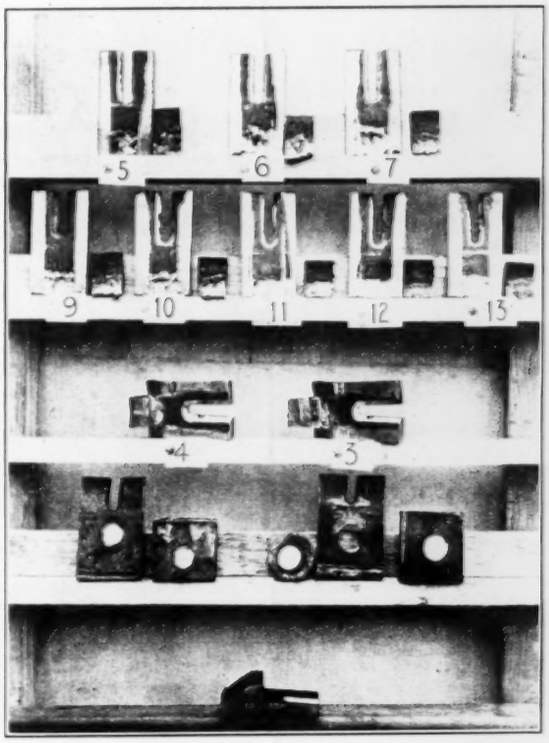

FIG. 15 SPECIMENS OF TYPE B

CONCLUSIONS

Some of the more important points brought out by the tests are enumerated and severally discussed below.

1 *Weak points in the containers.* None of the welded containers of standard design failed primarily at the welded head joint. The nature of the fracture shows that the weak points in the containers were, first, the lap weld in the pipe forming the shell, where failure occurred due to circumferential tension, and, second, the body of the shell at its junction with the head flange, where failure occurred due to the combination of longitudinal tension and bending. It appears that leakage is likely to occur first where couplings and nipples are welded in. This is due to the fact that the metal of the shell stretches and pulls away from the nipple, which does not have a corresponding strain induced in it by internal pressure.

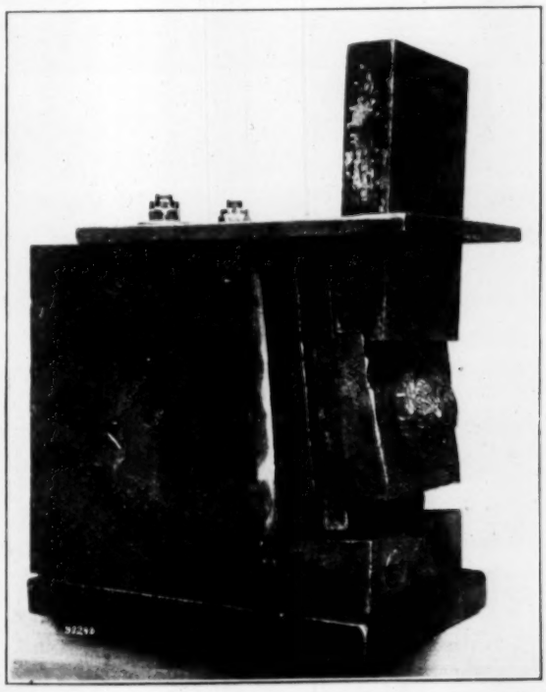

FIG. 14 SHEAR TOOL USED IN TESTING TYPE B SPECIMENS

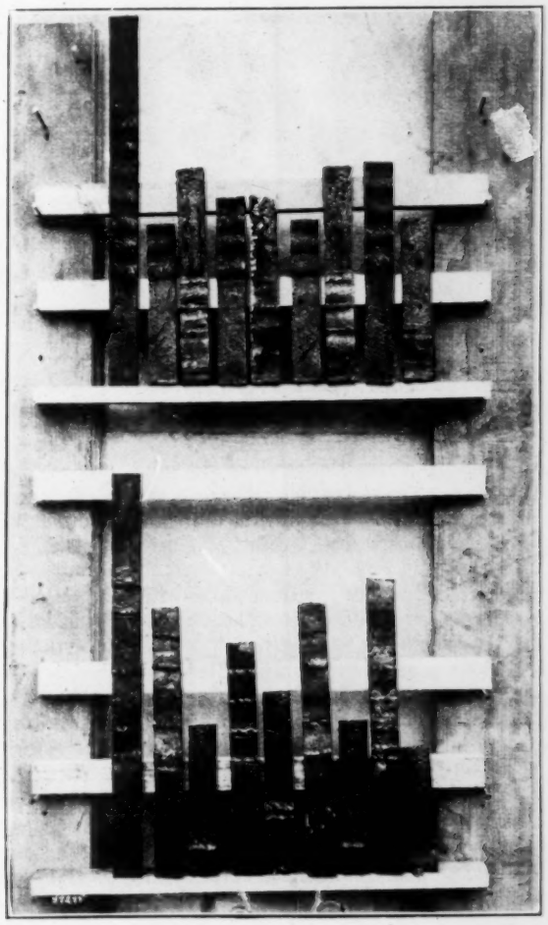

FIG. 16 SPECIAL SPECIMENS CUT TRANSVERSELY TO WELDED JOINTS, TESTED IN TENSION

2 *Strength of electric welds.* From the tests on four specially prepared specimens, the average tensile strength of electrically welded joints was found to be 28,500 lb. per sq. in. From tests on five specimens cut from containers, the average shearing strength of electrically welded joints was found to be 25,500 lb. per sq. in. The mean variation from the average tensile strength per linear inch of weld was found to be 2 per cent, and the maximum variation 4.5 per cent. The mean variation from the average shearing strength per linear inch of joint was found to be 5.2 per cent and the maximum variation 7.8 per cent. The results of eccentric tension tests on specimens cut from containers showed that no one of the specimens was markedly weaker than the average for the

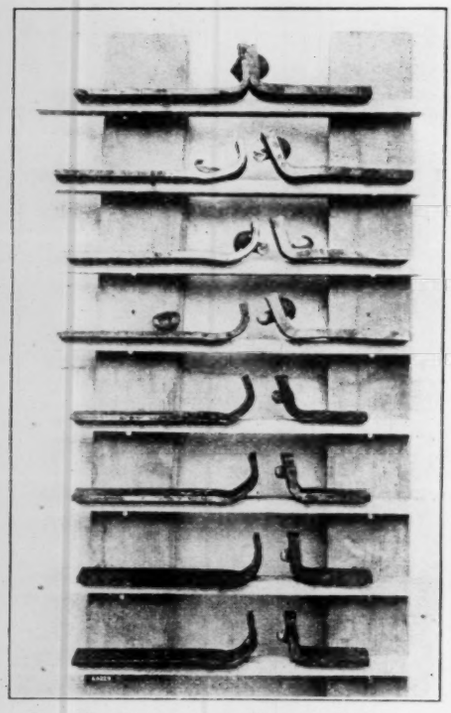

Fig. 17 Specimens of Type A, Riveted

lot. It is believed that the uniformity of strength thus indicated is of especial interest and importance.

In connection with the values given above for tensile strength, two points should be noted. First, at the section through the weld, where failure took place, the load was eccentric, because of the fact that the specimen is asymmetrically thickened at that point by the joint. This eccentricity undoubtedly made the average stress on the joint at failure less than it would otherwise have been, and so the values obtained were less than the actual tensile strength of the metal. The effective eccentricity was not as great as one half of the excess thickness of the joint, because the ends of the specimen were restrained. No attempt has been made to allow for the effect of this eccentric loading, because it represents a condition inherent in any so-called single-V weld which has an excess thickness.

Second, each of the four specimens had, within its tested length, several transverse welded joints. The strength of each specimen, therefore, represents the strength of the weakest of these seven joints, and so the value given, 28,500 lb. per sq. in., is less than the average strength for all the joints.

3 *Relative strength of electrically welded and riveted joints.* The tension tests on specimens of Type A indicated that the resistance to tension applied with a large eccentricity is greater for the riveted joint than for the welded joint. The shear test on specimens of Type B indicated that the resistance to shear per linear inch of joint is greater for the welded joint. Measurements to determine the elastic and permanent protrusion of the container heads showed that for the two specimens so tested the welded container withstood a somewhat greater pressure without permanent distortion. In the case of the riveted containers, leakage occurred at the head joints under moderate pressures. In the case of the electrically welded containers there was no leakage at the head joint under any pressure.

4 *Efficiency of electrically welded joints.* While it is customary to speak of the efficiency of a joint, whether welded or riveted, meaning the ratio of the strength of joint to strength of plates joined, the writer does not believe that this ratio is especially significant in the case of electrically welded joints nor that any value can be given it that can be regarded as generally applicable.

It is apparent that while the strength of the plates joined is dependent solely on the physical properties of the base metal, the strength of the weld is in great measure dependent on the properties of the filling metal. Furthermore, the per cent excess thickness of the weld, which influences its strength, varies with the thickness of the plates. Accordingly the efficiency of a weld depends on the properties of the base metal, the properties of the filling metal, and the thickness of the plates.

The writer believes that the correct method of computing the

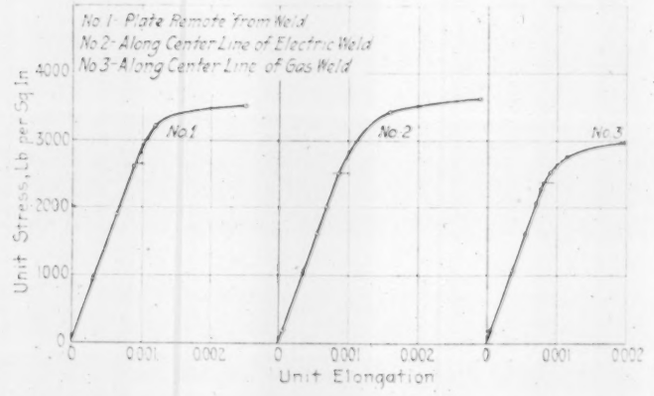

Fig. 18 Stress-Strain Diagram for Special Specimens Cut Parallel to Weld Joints

efficiency of an electrically welded joint is on the basis of a specified minimum strength of base metal, a specified minimum excess thickness of weld and an experimentally determined average strength (per sq. in.) of the metal, of which the finished weld is composed.

Liege Engineer Graduates to Hold International Congress

The Association of Graduate Engineers of the Liege School has scheduled an International Scientific Congress for June 11 to 16, on the occasion of the seventy-fifth anniversary of the Liege School. Graduate engineers of recognized schools and scientists of Belgium and the Allied Nations are invited to attend.

The Congress will include seven sections: mining, metallurgy, mechanical engineering, electricity, chemical industries, civil engineering and geology. A list of questions drafted to give an idea of some of the questions to be discussed has been published by the committee, and for the mechanical engineering section they cover turbines, reciprocating engines, jet apparatus, machine tools, transportation equipment, hoisting and handling machinery, special metallurgical apparatus, special mining machinery, applied hydraulics and thermo-dynamics, and combustion. Copies of these questions may be obtained by engineers expecting to be in Liege at that time, by application to the Editor of Mechanical Engineering.

The tentative program includes the unveiling of a War Memorial and the formal opening, a reception and banquet on Sunday, June 11, a reception by the University of Liege Monday morning, opening of the Assembly and meeting of Sections in the afternoon, a reception at the City Hall by the municipal authorities and a concert and ball at the Royal Conservatory of Music in the evening. Beside the meetings a reception at the Governor's Pallace is scheduled on Tuesday, formal closing of the Assembly on Wednesday and visits to the Exposition, to industrial works and points of interest until the closing of the Exposition on Saturday. Further information may be had by addressing O. Lepersonne, Secretaire-General de L'a. I. Lg., 16 Quai des Etats-Unis, Liege, Belgium.

Cotton-Ginning Machinery

By SOLOMON E. GILLESPIE,[1] DALLAS, TEXAS

Of the two classes of cotton grown in the United States—sea island or long-staple, and upland or green-seed—the former does not adhere to the seed and the lint can be pulled off clean by running it through rollers set close together, leaving the seed behind. Upland cotton, on the other hand, adheres to the seed, and the present paper is devoted to a description of the apparatus developed since Eli Whitney's epoch-making invention in 1792 for mechanically handling the raw seed cotton, removing the lint therefrom, and forming it into shape suitable for delivery to the baling press.

The cotton-ginning process comprises (a) elevating the cotton from the wagons in which it is brought to the ginnery to (b) a cleaner where the dirt, sand, leaf trash and other foreign substances are extracted; (c) elevating the cleaned cotton to (d) feeders which deliver it uniformly to (e) the gins where the lint is removed from the seed by the teeth of circular saws mounted at close intervals on a rotating shaft, from which teeth it is (f) cleaned off pneumatically and (g) carried to a condenser, where it is formed into a "bat" and delivered to a press box for packing, wrapping and pressing. The latest developments of the various devices employed in these steps are described and illustrated in the paper, and the author has included much valuable information for designers in the way of dimensions, relative proportions, speeds of operation, etc.

LONG before the dawn of history the cotton plant was cultivated in various parts of the world, and the earliest records of spinning its fleecy bolls are of such antiquity that it is difficult to obtain satisfactory evidence of its beginning. The name "cotton" itself is of Oriental origin, being derived from the Arabic "koton" or "gootn."

Before taking up the ginning of cotton it is well to consider its principal characteristics. There are two general classes or distinctive kinds of cotton grown in the United States, "sea island" and "upland." Sea island cotton does not adhere to the seed, and the lint can easily be pulled off clean, leaving the seed perfectly smooth. The staple varies from $1^1/_2$ in. to $2^1/_4$ in. in length, and is of a light creamy silk color. While strong, it is finer than other kinds and being but about 0.00063 in. in diameter, has a more beautiful luster.

Upland cotton adheres to the seed, and appears to grow out of them more like wool from a sheep's back. The seed, after being divested of lint as well as possible, still have a woolly appearance, and in a great many varieties a greenish color, and hence upland cotton often referred to as "green-seed" cotton. The stable varies in length from $^5/_8$ in. to $1^1/_8$ in., and its color ranges from white to a creamy tint. The staple is inferior in strength to the sea island type and coarser, being 0.00076 in. in diameter. The fibers are soft, elastic, moist and pliable, but the natural twist is rather inferior in character to that of sea island cotton, being irregular.

Good commercial cotton must possess certain well-defined external and internal characteristics. The external qualities, which are apparent to the touch or visible to the naked eye, are:

a Length of fiber
b Fineness or smallness of diameter
c Evenness and smoothness
d Elasticity
e Tensile strength
f Color

The internal characteristics, which are discernable by a microscope, are:

a Hollowness, or tubular construction
b Natural twist, due to the collapsed tube
c Corrugated edges
d Moisture

These characteristics are necessary to constitute a good mature cotton fiber, are essential in effecting the close union of the filaments, and make cotton superior to any other fiber, vegetable or animal. And since the cotton fiber has such a delicate structure and great value, it is necessary that the machinery used in its ginning and cleaning be of such character that the least damage will be done to the staple in the process.

The first method to be employed in separating cotton lint from the seed was that of hand picking. The next method, originated in India about 300 B. C., made use of rollers, which when running close together would pull the lint through and leave the seed behind. The roller gin is now used principally for ginning sea island or long-staple cotton and has gone through a long process of development and improvement.

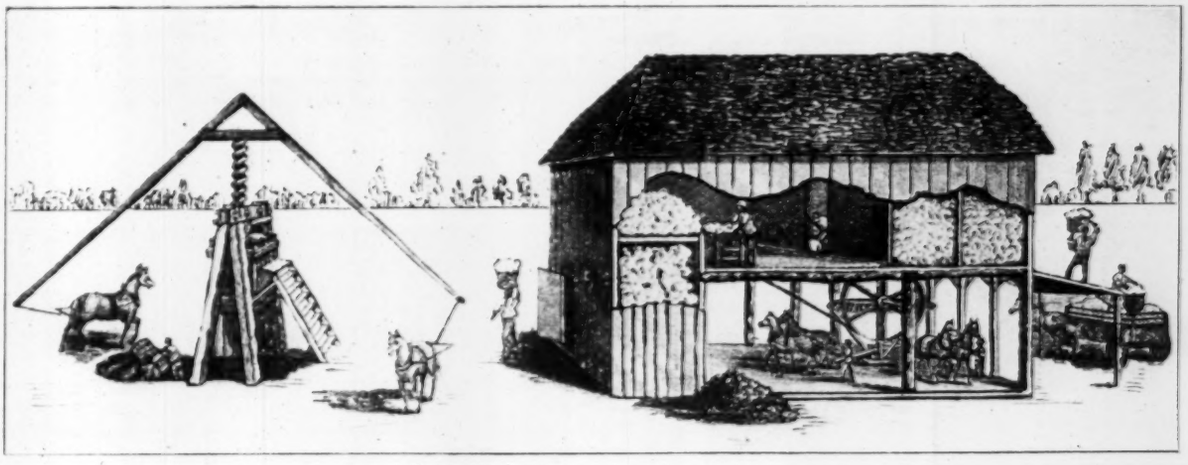

FIG. 1 EARLY TYPE OF GINNERY

In the United States the great problem that presented itself in the early days of the industry was that of removing the seed from the upland or green-seed cotton. The roller gin in its crudely developed state at that time would handle the sea island cotton to a certain extent, but was not adaptable to and suitable for the upland cotton.

In 1792 Eli Whitney, of Massachusetts, went by boat to Savannah, Georgia, and there developed the first cotton gin, for which a patent was granted him two years later. The original Whitney gin was a hand-power and hand-fed gin, consisting of a horizontal wooden cylinder about $7^1/_2$ in. in diameter and 2 ft. long, into which wire teeth were driven in rows spaced apart to admit the seed cotton but with the teeth in each row so close together as not to admit seed. The teeth were all inclined the same way, making an angle of 55 deg. to 60 deg with a tangent at the point of entry. The

For presentation at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922 of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th Street, New York. All papers are subject to revision.

[1] Mechanical and Industrial Engineer. Mem. Am.Soc.M.E.

cylinder had suitable bearings at each end and a hand crank, and above and in front of the cylinder was a hopper to receive the seed cotton, while directly over it was a breastwork or stripping grate consisting of a timber lined with a metal strip having a series of slots through which the rows of teeth could pass, taking the lint cotton but obstructing the seed. The lint was removed from the teeth by means of a cleaner or brush consisting of four sticks with bristles and so constructed that it formed a tangential cylindrical co-acting surface of bristles rotating in an opposite direction to that of the teeth and much faster. It was driven by an endless belt and idler. The gin was not continuous in action as are the gins of today, but had to have its seed dumped from time to time as they accumulated.

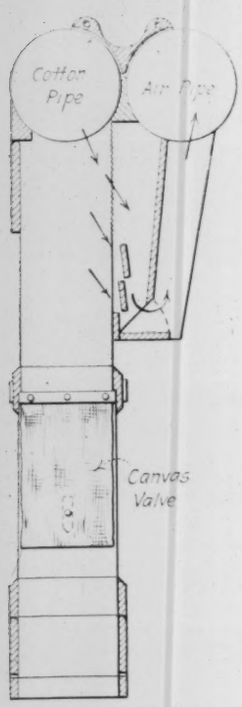

FIG. 2 PNEUMATIC ELEVATING SYSTEM FOR LARGE GINNERY

Two years later—May 12, 1796—a patent was issued to H. Ogden Holmes of Augusta, Georgia, on a hand-fed and hand-operated gin similar to Whitney's, except that it was continuous in operation, being so constructed that the seed would shed out as fast as they were delinted. This was also the first gin to use metal disks or saws, which were mounted on a square shaft with the ends turned down for bearings and the saws separated by space blocks. The brush contained more than four bristle-filled sticks, and was driven in reverse direction to that of the saws and four or five times as fast. This gin would shed the seed continuously as fast as delinted, and the roll of cotton in the roll box would revolve just as it does in the saw gin of today.

A little later, larger power-driven gins were employed, Fig. 1, the transmission consisting usually of a large 8-ft. wooden bevel gear mounted on a vertical axis with an extended beam or arm to which a horse or mule was hitched, and a horizontal shaft with a wooden pinion worked in conjunction with the large bevel gear, on which shaft a 12-ft. band wheel was mounted and from which the gin was driven at from 200 to 300 r.p.m. by means of a belt. In this system the gin was hand-fed from a platform above. The lint was discharged into a sack suspended beneath a hole in the floor back of the gin, sacking being the first system to be used in handling cotton in the market. Later, however, a lint room was built to receive the lint cotton, which was then carried out of doors, in baskets and put into a crude wooden press. This press was of very heavy mill construction, consisting of a single heavy box with discharge doors at the bottom and four large wooden corner struts or tension supports. An elevated platform was built of sufficient height to easily permit the placing of cotton in the press box from above, just below the overhead sills. The press screw was of wood and 15 in. in diameter with levers fixed to the top end and inclined downward to receive a rope to which a horse or mule was attached. Some presses had roofs over them, while others were left out in the open.

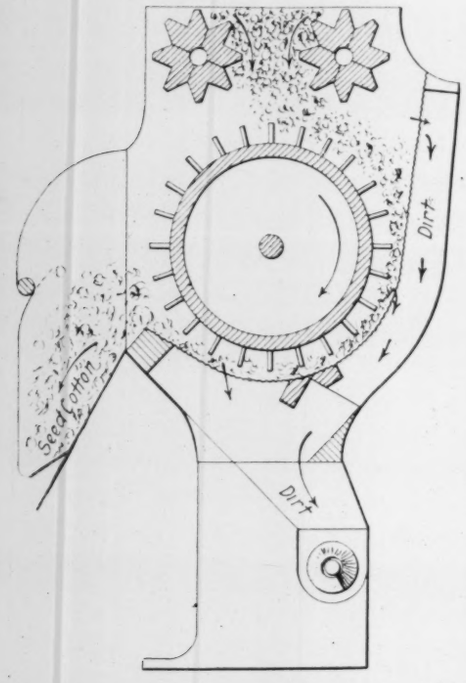

FIG. 3 FEEDER FOR GINNING ROLL BOX

The ginning system was later improved by the addition of a mechanical feeder over the gin and a single lint condenser back of it, and also by the employment of the steam engine for motive power. As the demand for larger output grew the ginneries were increased to two and three stands and the presses made more modern by the use of a 5 in. steel screw. In some cases the presses were equipped with large steam cylinders 30 in. to 36 in. in diameter, which operated much more rapidly than the screw press. These small ginneries were commonly known as plantation gins and were a part of the equipment of each large plantation. As the cotton industry grew, however, and the large plantations were superseded by small ones, custom gins came into use, doing away with the plantation gin and compelling inventors to seek better methods of caring for larger capacities at the gins. At first bell carriers were installed back of each battery of gins, which received the lint from each of the single condensers and delivered it to the press box. This crude system however, was later replaced by a single lint flue receiving the lint cotton direct from the various gin stands—which were in batteries of from two to six stands—and delivering it to a single large lint condenser or bat former, which then delivered it to the press. The lint flues were first constructed of wood, but later sheet iron was used, the diameter being about 18 in. at the smaller end and increasing as gins were added.

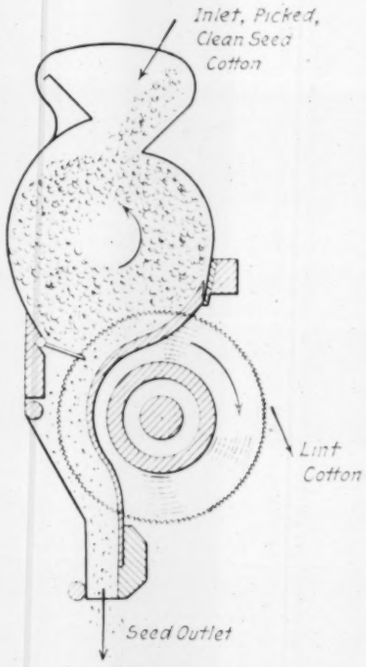

FIG. 4 PLAIN GIN

To care further for the large output of cotton at the custom ginneries, the revolving double-box press was developed. In this press one box acted as a receiving chamber from the condenser and was provided with a tramper or packer which packed 500 lb. of lint cotton in it, after which it was revolved around, bringing

the other (empty) box onto the receiving side while the one filled with cotton was pressed into a bale.

The standard cotton-bale boxes for presses are 27 in. by 54 in. by 10 ft.; the cotton is pressed from the latter dimension down to 36 in. and then six ties are put around it. Before being pressed, jute bagging is placed at the top and bottom of the cotton for wrappers. Upon releasing the pressure on the bale it usually expands from 40 to 42 in. making a finished bale 27 in. by 54 in. by 40 to 42 in. with a density of 12 lb. per cu. ft. A maximum pressure of 10,000 lb. is required in packing a bale of cotton in the receiving chamber and 70,000 lb. to press a standard bale.

Mechanical elevating systems were also developed for use in the large ginneries. The earlier designs were belt carriers, consisting of slats of wood nailed or riveted to two narrow belts, which would drag the seed cotton along from the point where it was fed on by hand to the point of delivery in the feeders. This process however, required too much human labor, and one comprising a suction fan with vacuum box and belt distributor was next devised.

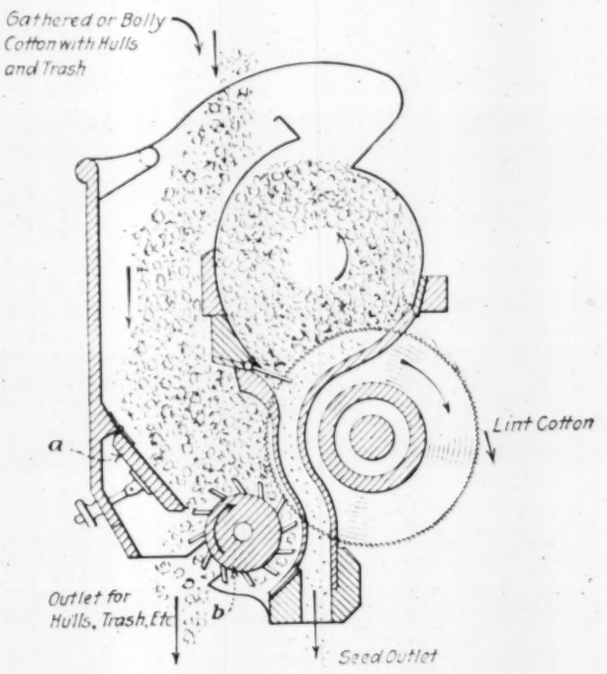

FIG. 5 HULLER GIN

In this system the cotton was sucked from the wagon through a pipe to the vacuum box in which there was a wire screen to separate the cotton from the air, the cotton then falling on the spiked belt distributor below, by means of which it was delivered to each gin feeder. The screen area in these vacuum boxes was 1 sq. ft. of $\frac{1}{4}$-in. mesh screen wire to 14 to 20 saws. The pneumatic elevating system, Fig. 2, was also invented and consisted of a vacuum chamber or elevator chute over each feeder and gin. This chute consisted of a chamber 12 in. by 53 to 60 in. by 6 ft. high with an air and cotton pipe at the top, a screen box attached on the upper back side and a heavy 12 to 16-oz. canvas valve near the center. This valve was so constructed that when the suction was applied it would close and prevent leakage of air through the valve causing suction in the telescope pipe in the wagon. This would deliver cotton into the several elevator chutes and then periodically the air would be cut off by means of a valve trip, thus releasing the air suction, and the canvas valves would drop the cotton into the gin feeder. The screen in the pneumatic elevator to separate the cotton from the air is usually light No. 21 gage, $\frac{1}{4}$-in. mesh wire, and the screen area is about one square foot to 10 saws. The fans used in these two elevating systems are of the steel-plate centrifugal type, varying in size from a 30-in. fan for a two-gin installation to a 45 to 50-in. fan for six gins. The peripheral speed of the suction fan-blast wheels varies from 11,000 ft. per min. to 13,000 ft. per min., which maintains a vacuum of 14 to 16 in. of water.

SEED-COTTON CLEANERS

There are many kinds of machines in use for cleaning seed cotton, but the general principle employed in them all consists of agitating the cotton on a wire screen of $\frac{1}{4}$ to $\frac{1}{3}$-in. mesh, permitting the dirt, sand, leaf trash and other foreign substances to escape.

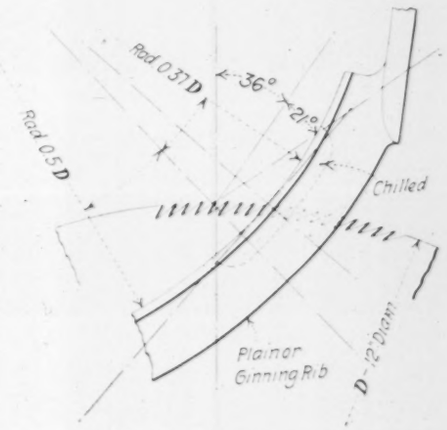

FIG. 6 DETAIL OF RIB AND SAW, PLAIN GIN

It is customary in some sections of the country, where climatic and other conditions interfere with the opening of the cotton boll, to provide a boll-breaking attachment to a cleaner. In some sections, where labor is scarce, the seed cotton is not carefully picked from the open bolls but is grabbed; that is, cotton, pod

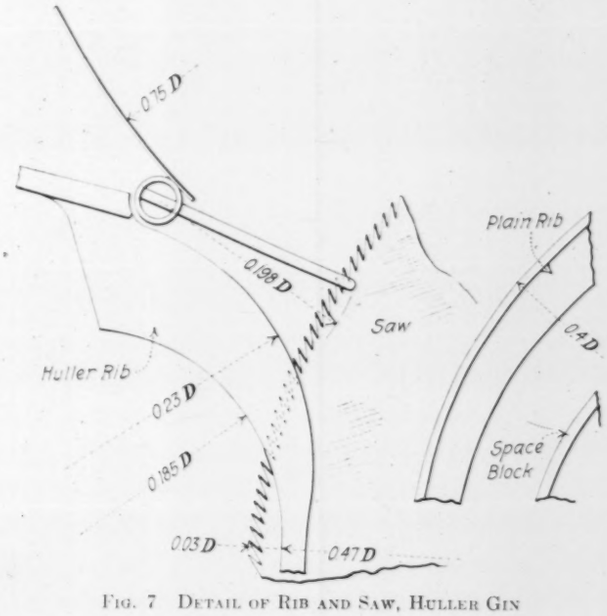

FIG. 7 DETAIL OF RIB AND SAW, HULLER GIN

and all are pulled off in a mass. In such cases the cleaning is an important item, because if not carefully handled the cotton will be damaged in the process. Some cleaning machines therefore have a cylinder of saws to separate the seed cotton from the pod or broken bolls; but this process is best accomplished in the huller gin which will be considered later.

FEEDERS

The feeder receives the cotton from the pneumatic elevator or belt distributor above it, and delivers it in a uniform, even amount to the ginning roll box. There are two general types of feeders, The horizontal slatted-belt type that receives the cotton from the belt distributor or pneumatic elevator on a very slow-moving slatted belt and moves it horizontally up to a spiked drum or picker roller 9 in. to 11 in. in diameter, rotates 180 to 200 r.p.m. and is provided with a series of No. 8 spikes projecting 1 in. from the surface. These spikes lift the cotton over and throw it down

a chute into the ginning-roll box. Another general type, Fig. 3 receives the cotton from the elevator chutes or belt distributor on to two fluted rollers 5 in. to 6 in. in diameter rotating toward each other at $^1/_2$ to 1 r.p.m., slowly feeding the cotton down where it is taken off by a picker roller similar to the one previously described, and is then whipped around a $^1/_3$-in. mesh No. 16 gage wire screen that partly surrounds the picker roller at a distance of about $^1/_2$ in. therefrom, threshing the light leaf trash and sand out of it before delivering it to the ginning roll box for the next process. The latest improved feeders are effective cleaning machines.

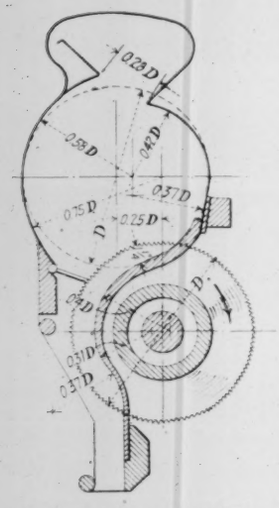

FIG. 8 PROPORTIONS OF PLAIN GIN ROLL BOX

THE SEED-COTTON GIN

The gin stand is the principal machine in the system as it performs the main work of separating the seed from the lint. There are two general types of saw gins, (*a*) the plain gin, Fig. 4, that gins only clean seed cotton that is substantially free from bolls and trash and is the original type used; and (*b*) the huller gin, Fig. 5, that separates the seed cotton from the bolls, burrs, leaf trash, dirt and other foreign substances in the front lower roll box, and then carries the seed cotton into the upper roll box where it separates the lint from the seed, thus performing a double ginning operation. The main working parts in both types of gins are the saws cylinder, roll box and a means of removing the lint from the saw teeth after it is separated from the seed.

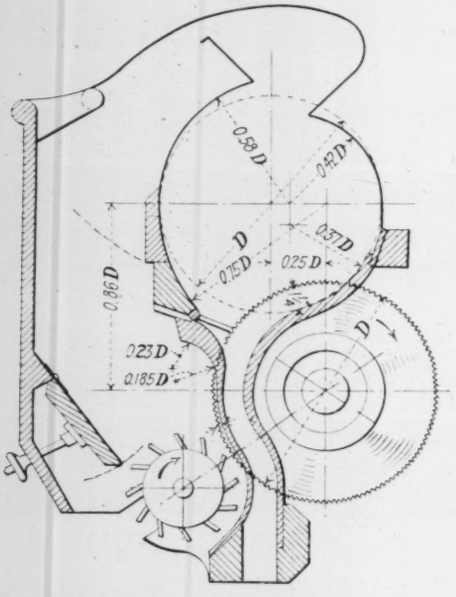

FIG. 9 PROPORTIONS OF HULLER GIN ROLL BOX

THE PLAIN GIN

The standard saw cylinder is made up of a series of 70 to 80 steel circular saws 10 to 12 in. in diameter and 0.035 in. thick, mounted on a $2^3/_{16}$ in. to $2^7/_{16}$ in. mandrel and separated by wood or iron space blocks 0.6835 in. to 0.7396 in. thick and $4^3/_4$ in. for 10 in. and 6 in. in diameter for 12-in. saws. The 12-in. diameter saw is considered best practice. The saw teeth all incline in the direction of rotation. There are seven teeth per inch, which are punched out and then filed smooth. This punching, however, crystalizes the saw steel to a certain extent and often results in defective teeth, with rough edges which are not noticeable to the naked eye but are very distinctly seen with a microscope. Some means should be devised for milling or grinding the teeth instead of punching to insure a perfect smooth tooth free from fracture and crystallization. The usual practice in the design of the tooth is to make both the front and back edges straight lines. In some cases, however, the front edges have been made straight and the back edges convex, resulting in what is known as "hog-back" teeth. The inclination of the teeth edges, Figs. 6 and 7, with a radial line through the point are 36 deg. for the front edge and 57 deg. for the back edge, the two edges making an angle of 21 deg. with each other at the point; this, however, may vary to suit certain working conditions later referred to. The saws rotate with a tooth travel of 1000 to 1250 ft. per min. for brush gins and 1400 to 1900 ft. per min. for air-blast or pneumatic gins.

The roll box, Fig. 8, consists of a series of ribs between the saws with a half-rib at each end, a back hollow above the ribs, an inlet opening or feed inlet at the top, a cover on the front side with a seed grate attached, and a shield or cover for the exposed portion of the saws below the roll box. In the development of the gin it was found by experiment that the process of ginning worked best by placing the roll box above the saws, thus permitting the roll of cotton to rest upon them, Fig. 4; the saw teeth in taking hold of the cotton fibers would cause the whole mass of cotton to revolve in reverse direction, and usually at about a fifth of their velocity, depending upon the quantity of cotton in the roll box and the hardness of the roll.

The cotton roll is theoretically round, Fig. 8, and the same diameter as that of the saws; but due to the following necessary working conditions its perfect roundness is distorted.

a The saws are caused to project up into the roll box from $1^1/_{16}$ in. to $1^3/_{16}$ in., $1^3/_{16}$ in., being considered the best practice. The cotton roll merely rests upon the saws, and the saw teeth, Fig. 4 only project into it. The cotton roll itself when rotating, is hollow, due to centrifugal force, and the cavity in the center is from 25 to 50 per cent of its diameter. It is best practice for the roll of cotton in the roll box to be as soft as possible, that is, with as large a cavity as possible, because this prevents the cotton fibers from wedging into the throats of the saw teeth, cutting and knapping the fibers, and also permits the fibers caught by the saw teeth to disentangle from the mass of the roll without breaking off; this precaution is especially necessary when the saw teeth are traveling at a high velocity.

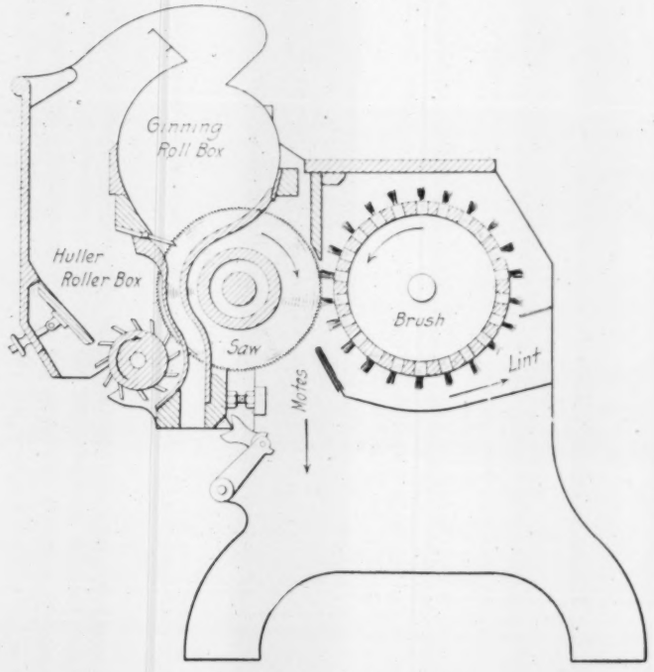

FIG. 10 BRUSH FOR REMOVAL OF LINT FROM SAW TEETH OF HULLER GIN

b The rib is tangent to the theoretical roll at its lower side; but the curve of the rib cuts up into the theoretical roll with a radius of 37 per cent of the saw diameter *D*, and at the upper edge of the

rib, from $1^1/_2$ to 2 in. above the point where the saw teeth pass through, there is an offset dropping the working line back tangent to the theoretical roll, to permit the cotton fibers that were pulled between the ribs and not carried away by the saw teeth, Fig. 4, to free themselves from the ribs. The ribs are usually made of cast iron and at the points where the saw teeth pass between them they are chilled, for an inch or so each way, Fig. 6, thus making a hard working surface that exhibits very little wear. The space between the ribs at the point where the teeth pass through is 0.125 in. wide and increases in width in each direction therefrom. The wearing surface of the rib as well as the edges are ground smooth and polished. The lower end of the rib is extended downward beyond the circle of the saw and attached to a rail or bar and the upper end extended just above the offset to attach likewise to a bar or rail, while the inner surface is ground to the curvature of the theoretical roll.

c The back hollow begins at the upper end of the rib, tangent to the theoretical roll, and curves inward and upward with a radius of 42 per cent of the saw diameter *D* to give the roll a proper density at the ginning point below and also pack it just before reaching the inlet opening at the top. This opening is 28 per cent of the saw diameter *D*, and is for the purpose of admitting cotton into the roll box at the top when operating as a plain gin.

d The front roll curves are the reverse of those of the rib and back hollow. The front is tangent to the theoretical roll at the intersection of the horizontal center line with it, and curves outward therefrom toward the top, to allow freedom for the admission of cotton, with a radius of 58 per cent of the saw diameter *D*. It also curves out from the center line toward the bottom with a radius of 75 per cent of the saw diameter *D*, to allow the roll to loosen so the ginned and cleaned seed will drop out. Near the bottom of this curve of the front there is a seed grate consisting of a pivoted rod with No. 8 fingers projecting out between the saws and extending $^1/_4$ in. inside of the saw-tooth curve. By raising the fingers or grates they press up against the bottom of the cotton roll and

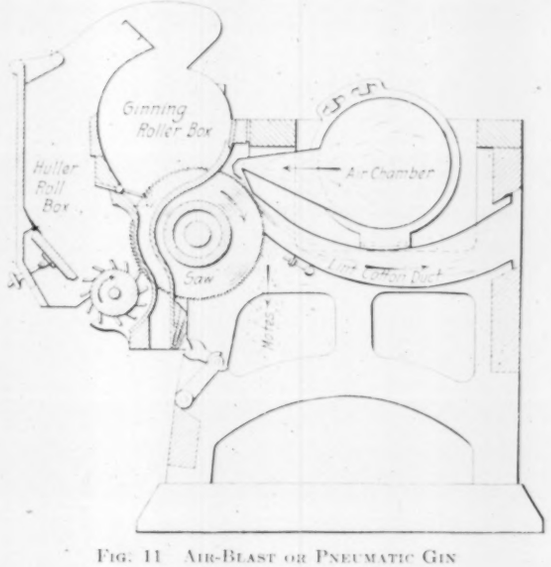

FIG. 11 AIR-BLAST OR PNEUMATIC GIN

retard the shedding of the seed, and by lowering them the seed are shed free; if lowered too much, however, the seed are released before the lint is entirely removed, Fig. 4, the ginning being thus regulated. The seed are shed out in the course of their travel from the seed grate to the point where the saw teeth pass between the ribs, the seed that are free from lint dropping out of the roll on to the ribs below and escaping to the seed conveyor below. The center of the roll box is not directly above the center of the saws because it would cause the ribs below to be too flat and not permit the seed to slide down out of the way, therefore the center of the roll box is 25 per cent of the diameter *D* in front of the vertical center line. The exposed portion of the saws below the roll box is covered with a shield to prevent injury to the operator; some roll boxes, however, have fronts that extend down and cover the exposed saws.

The saw teeth in traveling under the cotton roll take hold of some of the fiber and carry it between the ribs, leaving the seed in the roll box to be shed out as above explained. Each saw tooth that is loaded with lint cotton, amounting to from 0.000005411

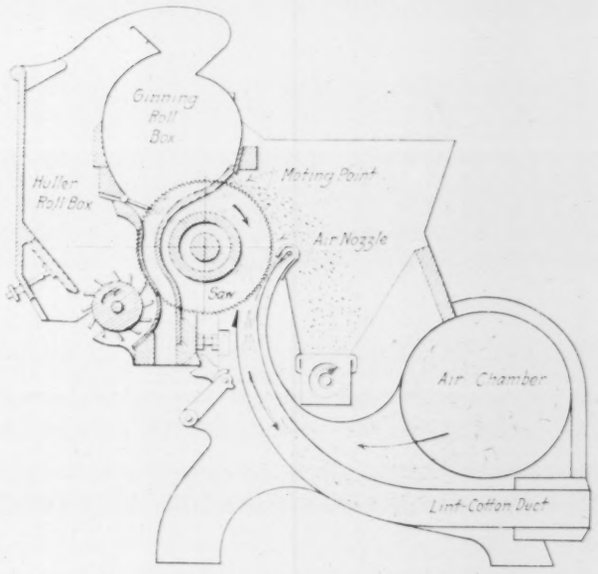

FIG. 12 ANOTHER TYPE OF PNEUMATIC GIN

lb. to 0.000004466 lb. per tooth for brush gins and from 0.000004025 lb. to 0.000000375 lb. per tooth for air-blast or pneumatic gins, being 100 to 160 fibers per tooth based on 29,000,000 fibers per pound, must be unloaded or cleaned before it returns to the roll box again. The removal of the lint from the saw teeth is accomplished by means of a brush, Fig. 10, consisting of a series of $^3/_4$ by 1-in. sticks, usually 22 in number, in which bristles are inserted usually projecting 1 in. from the stick. These sticks are mounted on a series of drum heads on a shaft $1^{15}/_{16}$ to $2^3/_{16}$ in. in diameter. The outside diameter of the brush cylinder is usually 15 in. Each brush has four wings 1 in. by 6 in. on each end head. In the operation of the brush gin the brush is set up to the saw cylinder so that the tips of the bristles overlap the saw teeth just $^1/_{16}$ in., and then caused to rotate in the reverse direction to that of the saws and at a peripheral speed of 6300 to 6900 ft. per min., or approximately six times as fast as the saw-tooth travel. When the bristles are new they have a wiping effect on the saw teeth, but after considerable use the tips wear off to such extent that they do not touch the saw teeth, and it is only the air blast generated by the brush that removes the lint. At the rear of the brush there is a board or sheet-metal cut-off, similar to that of a fan. And just above and between the saw cylinder and the brush there is a parting board that directs the air current on to the saw teeth, removing the lint and at the same time deflecting the motes out of the general current by centrifugal force with the assistance of the mote board, while the lint is blown into the lint flue below. The mote board is just below and between the saw cylinder and the brush, and is adjustable so that in the regulation thereof the motes just pass out while all of the lint cotton is caught in the lint flue. The usual air current or pressure produced on the saw teeth by the brush varies from 5 to 6.5 in. of water, and in its travel to the lint-flue main body it expands until the pressure in the flue is $^3/_8$ to $^1/_2$ in. of water.

The discovery that the air blast generated by the brushes had such an important part in removing the lint from the raw teeth led to the discovery of the pneumatic gin. Figs. 11 and 12, show two different types of this gin. One (Fig. 11) discharges the motes below, while the other, (Fig. 12) discharges them over the top of the air lip. In the early air attachments the discharge-nozzle opening was $^7/_{16}$ in to $^1/_2$ in. wide and extended 1 in. beyond each end saw; after continued development, however, these openings were reduced to $^1/_4$ in. to $^5/_{16}$ in. The air blown from the lip

a chute into the ginning-roll box. Another general type, Fig. 3 receives the cotton from the elevator chutes or belt distributor on to two fluted rollers 5 in. to 6 in. in diameter rotating toward each other at $\frac{1}{2}$ to 1 r.p.m., slowly feeding the cotton down where it is taken off by a picker roller similar to the one previously described, and is then whipped around a $\frac{1}{3}$-in. mesh No. 16 gage wire screen that partly surrounds the picker roller at a distance of about $\frac{1}{2}$ in. therefrom, threshing the light leaf trash and sand out of it before delivering it to the ginning roll box for the next process. The latest improved feeders are effective cleaning machines.

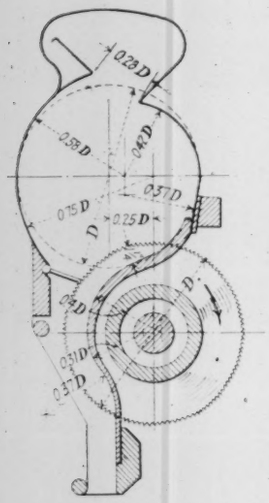

Fig. 8 Proportions of Plain Gin Roll Box

The Seed-Cotton Gin

The gin stand is the principal machine in the system as it performs the main work of separating the seed from the lint. There are two general types of saw gins, (*a*) the plain gin, Fig. 4, that gins only clean seed cotton that is substantially free from bolls and trash and is the original type used; and (*b*) the huller gin, Fig. 5, that separates the seed cotton from the bolls, burrs, leaf trash, dirt and other foreign substances in the front lower roll box, and then carries the seed cotton into the upper roll box where it separates the lint from the seed, thus performing a double ginning operation. The main working parts in both types of gins are the saws cylinder, roll box and a means of removing the lint from the saw teeth after it is separated from the seed.

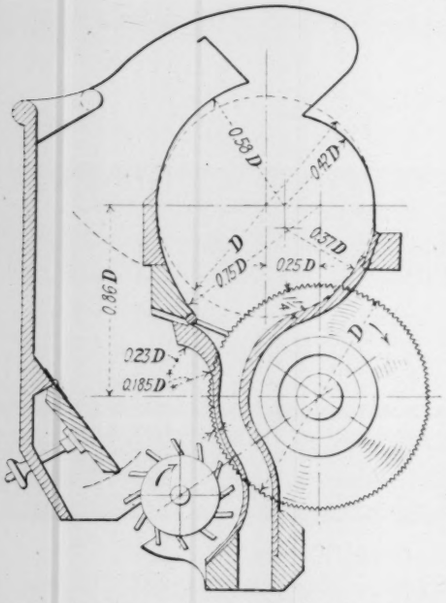

Fig. 9 Proportions of Huller Gin Roll Box

The Plain Gin

The standard saw cylinder is made up of a series of 70 to 80 steel circular saws 10 to 12 in. in diameter and 0.035 in. thick, mounted on a $2^{3}/_{16}$ in. to $2^{7}/_{16}$ in. mandrel and separated by wood or iron space blocks 0.6835 in. to 0.7396 in. thick and $4^{3}/_{4}$ in. for 10 in. and 6 in. in diameter for 12-in. saws. The 12-in. diameter saw is considered best practice. The saw teeth all incline in the direction of rotation. There are seven teeth per inch, which are punched out and then filed smooth. This punching, however, crystalizes the saw steel to a certain extent and often results in defective teeth, with rough edges which are not noticeable to the naked eye but are very distinctly seen with a microscope. Some means should be devised for milling or grinding the teeth instead of punching to insure a perfect smooth tooth free from fracture and crystallization. The usual practice in the design of the tooth is to make both the front and back edges straight lines. In some cases, however, the front edges have been made straight and the back edges convex, resulting in what is known as "hog-back" teeth. The inclination of the teeth edges, Figs. 6 and 7, with a radial line through the point are 36 deg. for the front edge and 57 deg. for the back edge, the two edges making an angle of 21 deg. with each other at the point; this, however, may vary to suit certain working conditions later referred to. The saws rotate with a tooth travel of 1000 to 1250 ft. per min. for brush gins and 1400 to 1900 ft. per min. for air-blast or pneumatic gins.

The roll box, Fig. 8, consists of a series of ribs between the saws with a half-rib at each end, a back hollow above the ribs, an inlet opening or feed inlet at the top, a cover on the front side with a seed grate attached, and a shield or cover for the exposed portion of the saws below the roll box. In the development of the gin it was found by experiment that the process of ginning worked best by placing the roll box above the saws, thus permitting the roll of cotton to rest upon them, Fig. 4; the saw teeth in taking hold of the cotton fibers would cause the whole mass of cotton to revolve in reverse direction, and usually at about a fifth of their velocity, depending upon the quantity of cotton in the roll box and the hardness of the roll.

The cotton roll is theoretically round, Fig. 8, and the same diameter as that of the saws; but due to the following necessary working conditions its perfect roundness is distorted.

a The saws are caused to project up into the roll box from $1^{1}/_{16}$ in. to $1^{5}/_{16}$ in., $1^{3}/_{16}$ in., being considered the best practice. The cotton roll merely rests upon the saws, and the saw teeth, Fig. 4 only project into it. The cotton roll itself when rotating, is hollow, due to centrifugal force, and the cavity in the center is from 25 to 50 per cent of its diameter. It is best practice for the roll of cotton in the roll box to be as soft as possible, that is, with as large a cavity as possible, because this prevents the cotton fibers from wedging into the throats of the saw teeth, cutting and knapping the fibers, and also permits the fibers caught by the saw teeth to disentangle from the mass of the roll without breaking off; this precaution is especially necessary when the saw teeth are traveling at a high velocity.

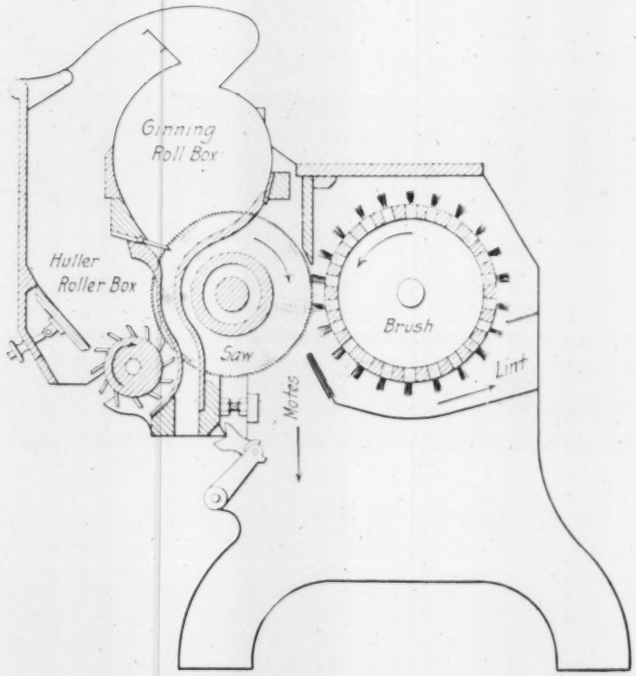

Fig. 10 Brush for Removal of Lint from Saw Teeth of Huller Gin

b The rib is tangent to the theoretical roll at its lower side; but the curve of the rib cuts up into the theoretical roll with a radius of 37 per cent of the saw diameter *D*, and at the upper edge of the

rib, from $1\frac{1}{2}$ to 2 in. above the point where the saw teeth pass through, there is an offset dropping the working line back tangent to the theoretical roll, to permit the cotton fibers that were pulled between the ribs and not carried away by the saw teeth, Fig. 4, to free themselves from the ribs. The ribs are usually made of cast iron and at the points where the saw teeth pass between them they are chilled, for an inch or so each way, Fig. 6, thus making a hard working surface that exhibits very little wear. The space between the ribs at the point where the teeth pass through is 0.125 in. wide and increases in width in each direction therefrom. The wearing surface of the rib as well as the edges are ground smooth and polished. The lower end of the rib is extended downward beyond the circle of the saw and attached to a rail or bar and the upper end extended just above the offset to attach likewise to a bar or rail, while the inner surface is ground to the curvature of the theoretical roll.

c The back hollow begins at the upper end of the rib, tangent to the theoretical roll, and curves inward and upward with a radius of 42 per cent of the saw diameter *D* to give the roll a proper density at the ginning point below and also pack it just before reaching the inlet opening at the top. This opening is 28 per cent of the saw diameter *D*, and is for the purpose of admitting cotton into the roll box at the top when operating as a plain gin.

d The front roll curves are the reverse of those of the rib and back hollow. The front is tangent to the theoretical roll at the intersection of the horizontal center line with it, and curves outward therefrom toward the top, to allow freedom for the admission of cotton, with a radius of 58 per cent of the saw diameter *D*. It also curves out from the center line toward the bottom with a radius of 75 per cent of the saw diameter *D*, to allow the roll to loosen so the ginned and cleaned seed will drop out. Near the bottom of this curve of the front there is a seed grate consisting of a pivoted rod with No. 8 fingers projecting out between the saws and extending $\frac{1}{4}$ in. inside of the saw-tooth curve. By raising the fingers or grates they press up against the bottom of the cotton roll and

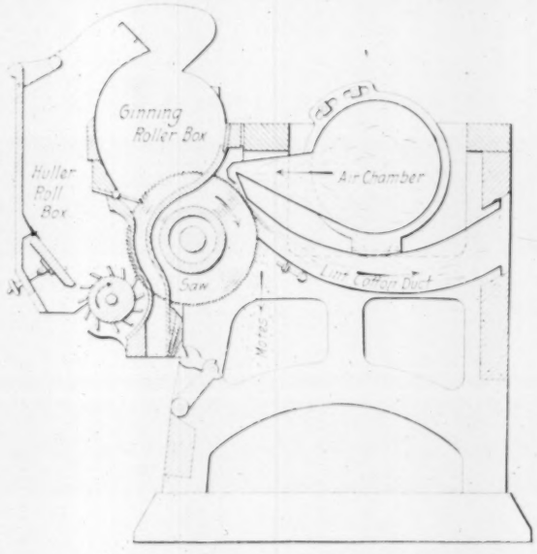

FIG. 11 AIR-BLAST OR PNEUMATIC GIN

retard the shedding of the seed, and by lowering them the seed are shed free; if lowered too much, however, the seed are released before the lint is entirely removed, Fig. 4, the ginning being thus regulated. The seed are shed out in the course of their travel from the seed grate to the point where the saw teeth pass between the ribs, the seed that are free from lint dropping out of the roll on to the ribs below and escaping to the seed conveyor below. The center of the roll box is not directly above the center of the saws because it would cause the ribs below to be too flat and not permit the seed to slide down out of the way, therefore the center of the roll box is 25 per cent of the diameter *D* in front of the vertical center line. The exposed portion of the saws below the roll box is covered with a shield to prevent injury to the operator; some roll boxes, however, have fronts that extend down and cover the exposed saws.

The saw teeth in traveling under the cotton roll take hold of some of the fiber and carry it between the ribs, leaving the seed in the roll box to be shed out as above explained. Each saw tooth that is loaded with lint cotton, amounting to from 0.000005411

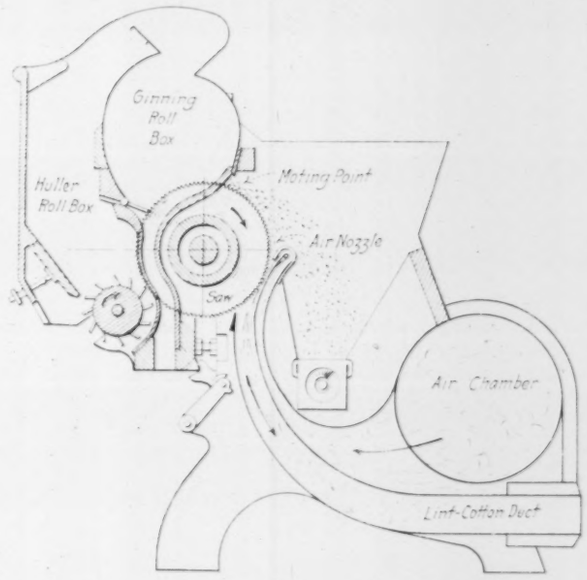

FIG. 12 ANOTHER TYPE OF PNEUMATIC GIN

lb. to 0.000004166 lb. per tooth for brush gins and from 0.000004025 lb. to 0.000000375 lb. per tooth for air-blast or pneumatic gins, being 100 to 160 fibers per tooth based on 29,000,000 fibers per pound, must be unloaded or cleaned before it returns to the roll box again. The removal of the lint from the saw teeth is accomplished by means of a brush, Fig. 10, consisting of a series of $\frac{3}{4}$ by 1-in. sticks, usually 22 in number, in which bristles are inserted usually projecting 1 in. from the stick. These sticks are mounted on a series of drum heads on a shaft $1\frac{15}{16}$ to $2\frac{3}{16}$ in. in diameter. The outside diameter of the brush cylinder is usually 15 in. Each brush has four wings 1 in. by 6 in. on each end head. In the operation of the brush gin the brush is set up to the saw cylinder so that the tips of the bristles overlap the saw teeth just $\frac{1}{16}$ in., and then caused to rotate in the reverse direction to that of the saws and at a peripheral speed of 6300 to 6900 ft. per min., or approximately six times as fast as the saw-tooth travel. When the bristles are new they have a wiping effect on the saw teeth, but after considerable use the tips wear off to such extent that they do not touch the saw teeth, and it is only the air blast generated by the brush that removes the lint. At the rear of the brush there is a board or sheet-metal cut-off, similar to that of a fan. And just above and between the saw cylinder and the brush there is a parting board that directs the air current on to the saw teeth, removing the lint and at the same time deflecting the motes out of the general current by centrifugal force with the assistance of the mote board, while the lint is blown into the lint flue below. The mote board is just below and between the saw cylinder and the brush, and is adjustable so that in the regulation thereof the motes just pass out while all of the lint cotton is caught in the lint flue. The usual air current or pressure produced on the saw teeth by the brush varies from 5 to 6.5 in. of water, and in its travel to the lint-flue main body it expands until the pressure in the flue is $\frac{3}{8}$ to $\frac{1}{2}$ in. of water.

The discovery that the air blast generated by the brushes had such an important part in removing the lint from the raw teeth led to the discovery of the pneumatic gin. Figs. 11 and 12, show two different types of this gin. One (Fig. 11) discharges the motes below, while the other, (Fig. 12) discharges them over the top of the air lip. In the early air attachments the discharge-nozzle opening was $\frac{7}{16}$ in to $\frac{1}{2}$ in. wide and extended 1 in. beyond each end saw; after continued development, however, these openings were reduced to $\frac{1}{4}$ in. to $\frac{5}{16}$ in. The air blown from the lip

opening continues to hug the sheet that leads to the lint-flue opening, and this sheet is brought up to within $^1/_{32}$ in. to $^3/_{32}$ in. of touching the saw teeth. The lint opening is just wide enough to receive all the air discharged from the air nozzle, and in addition thereto a small amount of the outside air is injected by the dynamic action of the air current. There is thus a slight current from the outside leading into the lint flue to insure that there will not be a loss of lint fibers on the outside, which would be the case if the reverse action took place. The air pressure at the nozzle outlet is usually

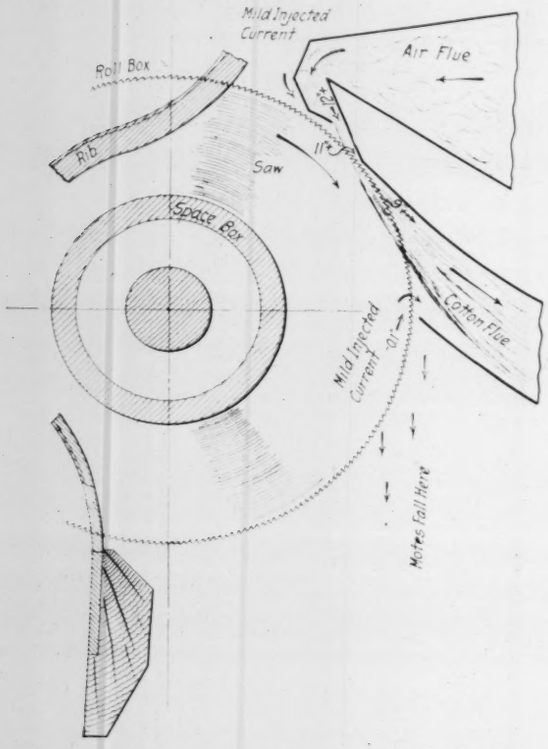

Fig. 13 Air Pressure at Various Points in Pneumatic Gin Shown in Fig. 11

from 8 in. to 12 in. of water. The various pressures for other points in and around the air nozzle for the two types of gins are as shown in Figs. 13 and 14. The pressure in the lint flue at the rear of the gins varies from 0.7 in. to 1.0 in. in the rear of the gins to 0.5 in. to 0.65 in. in the lint-flue uptake to the condenser.

The Huller Gin

The operation of the huller gin is very similar to that of the plain gin, in that the saw cylinders and the method of removing of the lint therefrom are the same. The roll-box construction is also the same, except that there is an additional huller roll-box in front of the ginning roll-box, Figs. 5 and 9, for separating the seed cotton from the burrs, sticks, trash, etc., and the cotton is delivered into the huller roll-box first, Fig. 5, and from there is carried up into the ginning roll-box by the saws; hence the feed to the ginning roll-box is from below instead of from the top, as is the case with the plain gin. The huller roll-box, Fig. 5, consists of a chamber in which the cotton is fed, and this chamber has a hinged removable front cover *a* with an inclined sheet or board for regulating the refuse discharge, and a huller picker roller *b* $2^1/_2$ to $4^1/_4$ in. in diameter with 10 to 16 longitudinal rows of No. 8 spikes set at an angle of 30 deg. to radius of point where they enter roller. These spikes are alternated and in circular rows of 5 to 8 spikes between each pair of saws, and project out $^3/_4$ in. to 1 in. from the roller, which rotates at from 300 to 700 r.p.m. There is also a set of huller ribs, Fig. 7, to prevent the hulls and trash from being carried into the upper or ginning roll box, thus performing a double ginning process. The huller ribs partly surround the huller picker roller, Fig. 9, and the outer or working surface of the rib is $^1/_4$ to $^3/_8$ in. from the tips of the saw teeth; just below the seed grate the rib curves out and is fixed to a rib rail or bar.

In the operation of the huller gin the cotton, Fig. 5, is fed into the huller roll box, the spiked picker roller rotating in the reverse direction to that of the saws, spikes inclining backward. The cotton is thus thrown on to the saw teeth and carried up into the ginning roll, leaving the trash, a part of which is shed out; but as the quantity increases, the box front is swung out by hand, discharging the foreign substances. When there is a large amount of trash the picker roller is pulled out from the ribs and the inclined board moved back, thus permitting the trash to shed out in front of and behind the roller; but if there is only a small quantity, the huller roller should be set up close to it, to prevent the dropping of locks of cotton. The huller ribs are spaced sufficiently apart at the point where the teeth pass between to permit the seed cotton to pass through into the ginning roll box. The lint is removed from the saw teeth by means of a brush or current of air as has been described for plain gins, and the operation of the ginning roll box in shedding the seed is the same. The lint cotton is removed from the saw teeth and passed into the lint flue which has inlets from the various gins set in battery. The size of the lint flue

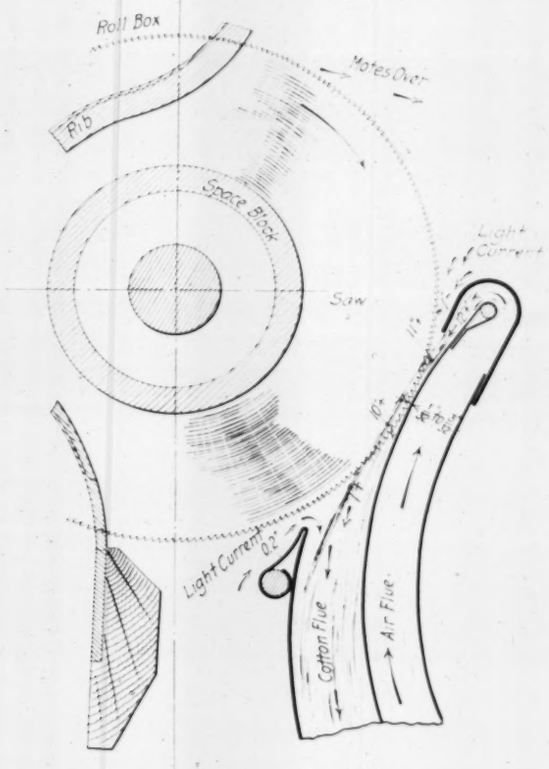

Fig. 14 Air Pressure at Various Points in Pneumatic Gin Shown in Fig. 12

varies according to the number and size of gins, the general practice being to have about three square inches per saw.

The Condenser

The lint flue delivers the cotton into the condenser which consists of a large horizontal drum covered with 8-mesh No. 21 wire screen. The drum is usually 54 in. long, the same as the cotton bale, and its diameter is usually 30, 40, 50, 60, or 72 in. respectively, for 100, 175, 250, 325 or 400 saws. The screen drum, Fig. 15, is mounted in a housing that spirally circumscribes it with air outlets at the ends and two doffing rollers at the discharge side, the lower one having flaps of thin $^3/_{32}$-in. light cloth-backed rubber. The rollers receive the lint cotton from the drum and deliver it on the lint slide and then into the receiving chamber of the press box. The portion of the screen drum exposed to the cotton air current is about 75 per cent, and there is 1 sq. ft. of screen provided for every 5 to 6 saws; but when the drum rotates it travels at a rate of speed of 50 to 80 ft. per min. for the smallest up to the

(Continued on page 242)

Reduction of Fuel Wastes in the Steel Industry

By F. G. CUTLER,[1] ENSLEY, ALA.

The paper sets forth the economy of utilizing blast-furnace gas, at one time considered to be of little material value, in reducing the wastes of the steel industry. It is shown how the quantity of gas to be expected in the production of one ton of pig iron may be computed, and the uses to which this gas may be put are analyzed quantitatively. A heat balance, based on the production of one ton of pig iron is presented, showing the sources of heat and the requirements for blast-furnace and steel-mill operation. It shows that the total heat from the by-products of a ton of pig iron is more than sufficient to finish a ton of steel. The heating requirements are not met by the tar and by-product gas, although the average power requirements are more than met by the blast-furnace gas and coke breeze. It therefore becomes desirable to reduce the heating requirements for the production of steel by using more efficient heating furnaces, and to conserve all possible heat by charging hot steel into the soaking pit and reheating furnaces, in order to reduce the quantity of fuel required for supplementary heating.

IN order to show the relative proportion of the energy in the shape of heat or power required for the manufacture of steel that is utilized from the fuel by-products of the manufacturing process, the following figures have been prepared showing the quantity of heat derived from the by-products of the manufacture of pig iron.

In the production of one ton of pig iron, from under 1800 to over 3000 lb. of coke are used, this variation being due to difference in metallic content of the charge, condition of the furnace lining, quality of coke, etc. The heat energy of this coke is utilized in the reduction of the ore to pig iron and changing the impurities to a slag; a part is lost in radiation, and approximately half is delivered at the top of the furnace in the shape of gas for use under boilers for the production of steam, or in gas engines for the production of power. The gas has also been used in soaking pits, in by-product oven heating, ladle drying, etc., and other uses have been proposed, but by far the greatest quantity has been used under boilers.

It has been only within the last few years that blast-furnace gas has been considered to have any material value. In the past there has been no recognized method of determining whether or not a blast-furnace plant has been guilty of wasteful practice, or if guilty, what the extent of this waste might be, and it is the intention of this paper to propose a standard method of comparison of total combustion efficiency, both with the idea of determining, for any particular plant, the relative efficiency, from day to day or month to month, as well as for the comparison of one blast-furnace plant with another, for the information of the management and the engineers in determining the necessity for improvement in equipment or personnel.

Heat Available from the Blast Furnace

In proposing this standard comparison reference is made to Fig. 1 which is taken from Mr. Brassert's paper on Modern Blast Furnace Methods, published in the year book of the American Iron and Steel Institute in 1914. This chart shows the effect of variation in coke rate upon the heat value of blast-furnace gas at 62 deg. fahr. As blast-furnace gas leaves the top of the furnace it usually has a temperature of from under 300 to over 600 deg. fahr., generally averaging about 400 deg. fahr. At this latter temperature, the sensible heat of the gas is equivalent to about 8 B.t.u. per cubic foot of gas at 62 deg. The B.t.u. per cubic foot of blast-furnace gas according to Brassert is $62.5 + 0.016R$, where R = lb. of dry coke per ton of pig iron; and including sensible heat of the gas at 400 deg. fahr. would be equal to $70.5 + 0.016R$. The cubic feet of gas per ton of pig iron (as shown by Brassert) is equal to $71.4R$, so that in the top gas from a furnace at 400 deg. fahr. the B.t.u. per ton of iron is $1.142R^2 + 5033.7R$. Brassert also gives the cubic feet of air per pound of coke equal to $51.4R$, so that both gas production and the blast requirement bear a direct ratio to the coke consumption of the furnace per ton of iron. The figures given in Mr. Brassert's paper, so far as the author has been able to discover, are applicable to all blast furnaces using coke as fuel.

Heat Required for the Stoves

The blast is heated in stoves under pressure, and the heat required per cubic foot of blast is proportional to the rise in blast temperature in the stove, and inversely proportional to the efficiency of the stove, which is usually considered to average 60 per cent. After the necessary gas is used to heat the blast, the remainder can be measured in the shape of power. Any increase in stove or boiler efficiency or reduction in leakage of gas, etc., is reflected in increased surplus power, and as we are largely interested in the surplus power, after the blast furnace requirements are satisfied, any error in the assumptions relative to the efficiency

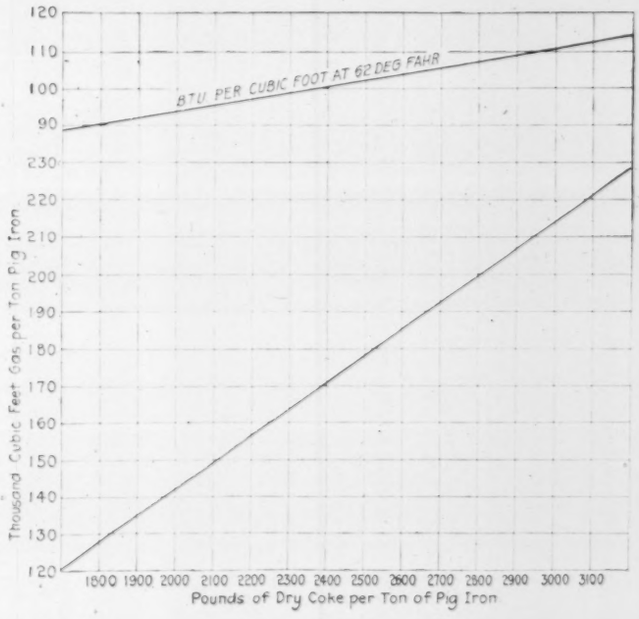

FIG. 1 EFFECT OF COKE RATE ON PRODUCTION OF BLAST-FURNACE GAS

of the stoves is of minor importance, particularly as the stoves use the smaller fraction of the total. The blast supplied from the blowing engines is heated by compression to about 150 deg. fahr., varying somewhat with blast pressure, etc., and is usually heated in the stoves to from 1150 to 1350 deg. fahr. In the following calculations it has been assumed that 0.02 B.t.u. are required per cubic foot of blast per deg. fahr., that the blast is heated in the stoves to 1250 deg. fahr., that the average overall stove efficiency (i.e., ratio of heat given to the blast to the heat in the gas) is 60 per cent and that 55 cubic feet of blast are heated per pound of coke charged.

The heat required in the gas for heating the blast for one ton of pig iron to a temperature of 1250 deg. fahr. can therefore be expressed by the following formula where H = B.t.u. per lb. of coke burned in the blast furnace.

$$H = \frac{(1250 - 150) \times 0.02 \times 55R}{0.60} = 2020R$$

The heat in gas per ton product after the blast is heated is, therefore, $1.142R^2 + 3013.7R$. For other top temperatures and blast temperatures the constants will change slightly.

[1] Chief of Bureau of Steam Engineering, Tenn. Coal, Iron & R.R. Co.

Abstract of paper to be presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Copies of the complete paper may be had upon application. All papers are subject to revision.

Heat Required for Gas-Fired Boilers

In order not to enter into the discussion of the relative merits of steam vs. gas engine, surplus uncooled gas, after the stoves are heated, will be assumed to be used under boilers. In one boiler horsepower-hour there are 33,305 B.t.u., and assuming that the "standard" efficiency of blast-furnace-gas-fired boilers is 66.6 per cent, in one boiler horsepower-hour $\frac{33,305}{0.666} = 50,000$ B.t.u. would be required in the gas, so that the boiler hp-hr. per ton would be $\frac{\text{Surplus B.t.u. per ton iron}}{50,000 \text{ B.t.u.}}$. As the blast furnace product is usually expressed in tons per day the average boiler horsepower per hour generated from blast furnace gas under the above conditions can be expressed by the formula:

Average boiler horsepower per hour per ton of pig iron per day

$$= \frac{1.142R^2 + 3013.7R}{50,000 \times 24}$$

In assuming the standard efficiency of 66.6 per cent for boilers and 60 per cent for stoves, it should not be understood that these are the maximum efficiencies that can be attained, but rather that they are taken as a standard for comparison and represent average practice that can be maintained in a fairly modern plant which is correctly designed, and which is operated by reasonably intelligent men.

Using the above, Fig. 2 has been prepared. This chart also shows the per cent of top gas required for heating the blast to an average of 1250 deg. fahr. with the stoves of 60 per cent total efficiency. This chart can be used by the blast furnace superintendent or engineer to determine the horsepower that should have been generated from gas for any period. From the actual results as shown by a meter on the boiler feed line, after deducting an allowance for steam generated by coal firing (usually small) or for gas used by gas engines, it will be possible to determine whether the total efficiency, including stoves and boilers, is above or below the standard.

The following table shows the boiler horsepower-hours per ton of pig iron for several coke rates as calculated from the above formula.

Pound of Coke per Ton	Boiler-Horsepower-Hours per Ton Product	Boiler-Horsepower-Hours per Ton per Day
2000	211	8.8
2200	242	10.1
2400	276	11.5
2600	310	12.9
2800	348	14.5
3000	386	16.1

To furnish the blast to the furnace with either high-pressure condensing, turbo-blowers or reciprocating steam engines requires about 70 boiler hp-hr. per ton of coke burned in the blast furnaces, and to operate the various furnace auxiliaries, such as pumps, air compressors, steam bells, mud guns, hoists, etc., requires from 15 to 25 boiler hp. per ton of product, so that after the furnace requirements have been met, there is available for the generation of power from 100 to 250 boiler hp-hr. per ton of pig iron, depending on the coke burned in the furnace.

At 2 kw. per boiler hp-hr., this means that from 200 to 500 kw-hr. per ton of pig iron is possible with steam equipment from the surplus gas from the blast furnaces.

Heat Required for Manufacture of Steel from Pig Iron

The manufacture of steel from pig iron in the open hearth requires heat for melting scrap and fluxing the impurities, and power for the various operations incident to this process. The quantities of heat and power required vary materially with different plants on account of difference in equipment, practice, etc., but for the purpose of this paper it will be assumed that a ton of ingots requires one ton of pig iron plus enough scrap to offset the losses and this work requires from 5,000,000 to 9,000,000 B.t.u. and an expenditure of from 20 to 30 kw-hr. per ton. This ton of ingots will make about 0.85 ton of blooms, and the heating in soaking pits will require from 1,500,000 to 3,500,000 B.t.u. per ton of steel depending upon the temperature of the steel arriving at the pits, rate of operation etc., and the rolling of the ingots into blooms will require from 40 to 60 kw-hr. per ton. From the blooming or slabbing mill the material, usually reheated at an expenditure of from 2,500,000 to 6,000,000 B.t.u. per ton, is furnished to finishing mills, the power required, depending on the reduction of section, temperature of rolling, etc., varying from 35 to over 300 kw-hr. per ton.

Utilization of Industrial Wastes

Waste heat from open hearth and heating furnaces and kilns is utilized for the production of steam, and otherwise waste steam is utilized in low or mixed pressure turbines for the production of power, but as these subjects have been discussed many times, and are not peculiar to the steel industry, they will not be discussed except to say that while these economies are many times worth while in existing plants, very few new installations as designed include waste-heat boilers with furnaces, or low-pressure turbines as integral parts of new power plants.

Surplus by-product gas, after the ovens are heated, is sold for use as domestic fuel, etc., replacing natural gas, water gas, etc., and is used in the steel plant for melting steel in the open hearth, and for various heating operations in the steel industry. In former years this material was considered as having only nominal value, and it was but rarely that any attempt was made to utilize it efficiently.

With the advance in fuel prices, shortage of natural gas, etc.,

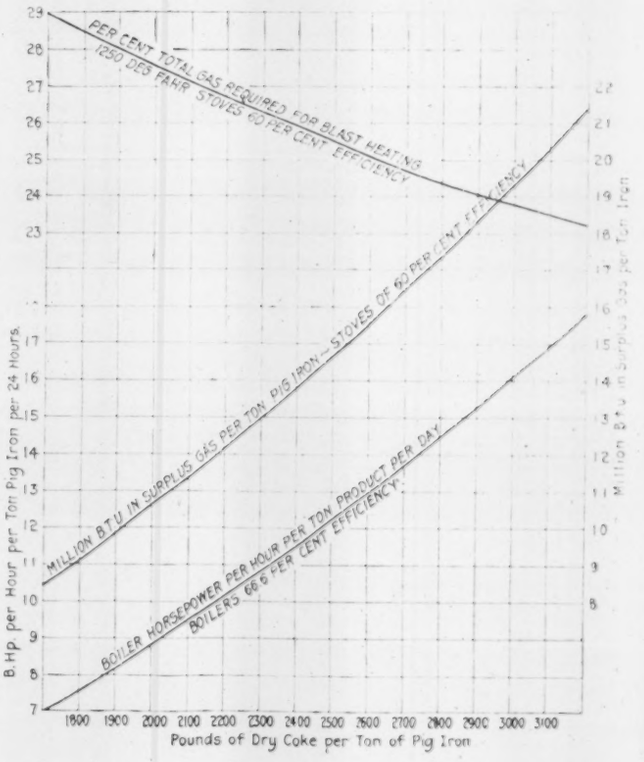
PER CENT TOTAL GAS REQUIRED FOR BLAST HEATING
1250 DEG FAHR. STOVES 60 PER CENT EFFICIENCY
MILLION B.T.U. IN SURPLUS GAS PER TON PIG IRON—STOVES OF 60 PER CENT EFFICIENCY
BOILER HORSEPOWER PER HOUR PER TON PRODUCT PER DAY
BOILERS 66.6 PER CENT EFFICIENCY
B. Hp. per Hour per Ton Pig Iron per 24 Hours.
Million B.T.U. Surplus Gas per Ton Iron
Pounds of Dry Coke per Ton of Pig Iron
1800 1900 2000 2100 2200 2300 2400 2500 2600 2700 2800 2900 3000 3100

Fig. 2 Effect of Coke on Production of Power from Surplus Blast-furnace Gas

and also largely due to special heating requirements connected with the manufacture of artillery and ammunition during the war, a number of combustion systems were developed that by more or less accurately regulating the proportion of air to gas have greatly increased the combustion efficiency of heating furnaces, and the control of combustion has been found of great importance in the maintenance of economy.

Dust coke breeze, from the coke plant (i.e., the material through a $\frac{1}{8}$-in. screen), is used to cover molten pig iron in transit from the furnaces and in making bottoms of soaking pits and heating furnaces. A great deal of this material which was thrown away or more or less inefficiently burned on hand-fired grates or, by mixing with slack, on mechanical stokers, is now more efficiently burned by itself, on traveling-grate forced-blast stokers.

Tar, either before or after the creosote oils have been removed, has been found to be a very good fuel for open-hearth furnaces,

(Continued on page 242)

Hydroelectric Installation on the Kern River

Two Turbo-Generators Arranged for Dual Operation at Either 50 or 60 Cycles—Unique Equipment for Efficient Use of Water Supply

By ELY C. HUTCHINSON,[1] SAN FRANCISCO

As the Kern River No. 3 Plant of the Southern California Edison Company marks the most important forward step in hydroelectric practice in recent years, a brief review will be given of the reasons leading to its development.

The plant is required to supply 60 cycle current for pumping plants to irrigate the growing crops in the San Joaquin Valley during the summer season, when the demand in Southern California is comparatively low. With the approach of winter, the pumping load, and with it the demand on the 60 cycle system decreases, while at the same time, the demand on the 50 cycle in Southern California increases. To meet this condition the plant must be connected into the general transmission system supplying the Southern California territory. This dual requirement is further complicated by a widely varying seasonal flow of the river with no opportunity for storage.

The power house is a reinforced concrete building 88 ft. wide and 130 ft. long, situated on the bank of Kern River. Tail water from the turbines is returned directly to the stream. The generator equipment consists of two 17,500 kva. General Electric Company vertical units, operating 3-phase at 11,000 volts for 60-cycle and 10,000 volts for 50-cycle current. They are provided with Reist spring type, water-cooled thrust bearings for supporting the entire rotating element inclusive of the hydraulic turbine runner and shaft. As is explained later, the turbines are designed so that an uplifting force is produced within the casing, thus reducing the load on the thrust-bearings.

The hydraulic turbine and their auxiliaries are of particular

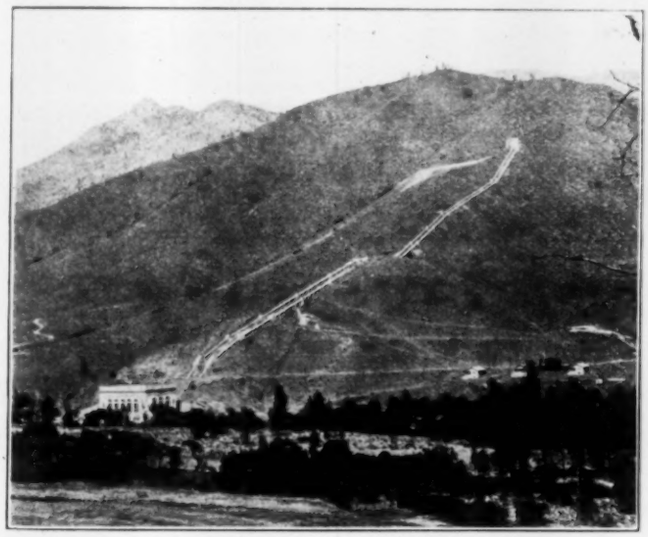

Fig. 1 Exterior of Power House

interest, as they are operating under the highest head ever attempted with turbine construction, and contain many novel features essential to success under the conditions. The operating requirements may be summarized as follows:

Effective head—780 ft. to 820 ft.

Water quantity—variable, from full supply for two units to less than sufficient for one under full load. No storage.

Generating frequency—either 50 or 60 cycles. Both units can be operated at 60 cycles, both at 50 cycles, or either unit can be operated at 60 cycles and the other at 50 cycles.

Speed—for 60 cycles, 600 r.p.m. For 50 cycles, 500 r.p.m.

The operating guarantees were:

Capacity—22,500 hp. per unit for either 50 or 60 cycle operation. (They are however operated almost continuously at 25,000.)

Efficiency—90 per cent maximum, either at 50 or 60 cycles.

Maximum speed rise—full load rejection, 60 cycle, 21 per cent, 50 cycle, 29 per cent.

Maximum pressure rise—full load rejection, 50 and 60 cycle, 20 per cent.

The turbines were designed and built by the Pelton Water Wheel Company's San Francisco Works. They are of the vertical type as shown in Fig. 2.

The casings are of cast steel, made in halves and bolted to a cast-steel speed-ring made in one piece. The casing covers are made of cast iron. The upper cover is constructed to support the turbine bearing, which is of the external babbitt-lined type. Leak-

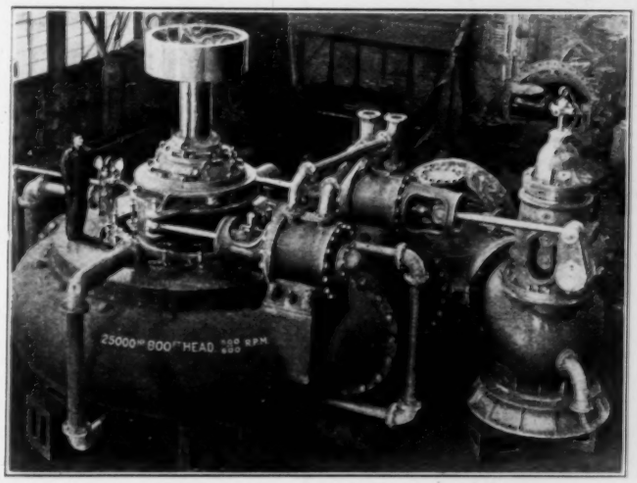

Fig. 2 Turbine in Place but Generator Not Connected

age from the inside of the turbine casing is prevented by a stuffing box of unusual design.

Owing to the high internal pressure and high rotating speed of the shaft, it was necessary to make special provisions for cooling the stuffing box. This was accomplished by fitting a water-jacketed, renewable wearing-sleeve over the shaft, and arranging to pack the stuffing box only loosely with specially designed metallic packing-rings. Any possible water seepage is drained off to tail water by means of an automatic ejector device.

Two interchangeable bronze runners are provided for each unit, one for 50 and the other for 60-cycle operation. These runners may be changed and the unit put back on the line in twenty hours by means of an interesting set of devices, for which patent application has been made. The procedure is as follows:

The runners fit on a tapered extension of the main shaft, which is hollow. A special portable hydraulic jack, which connects rigidly to the shaft, is used to force the runners on or off. The draft tube has two removable cast iron sections, each permanently provided with 4 roller-bearing car-wheels. These sections are lowered to rails set into the floor, after which they are rolled out or the way to give free access to the runner. All parts are raised of lowered by the power house crane with the hoisting cable passing through the hollow shaft.

One of the draft-tube sections acts as a carriage for the runner, which is thus wheeled to an open hatchway. Here the change is made from 50 to 60 cycle, or vice versa, with the station crane.

[1] Engineer, Pelton Water Wheel Co.

Abstract of a paper presented at a meeting on March 23, 1922, of the San Francisco Section of The American Society of Mechanical Engineers.

The new runner, on its carriage, is then wheeled to position below the turbine casing and hoisted into place. The change of runners is made without disturbing the gate-rigging or the guide-vanes, which are carried in grease-lubricated bronze bearings at both ends.

On account of the high-operating head, the design of the water-seal rings between the rotating runner and the turbine casing called for careful study. It was finally decided that all seal-rings should be made removable and renewable, whether on the runner or in the casing covers. Straight face concentric clearance rings of rolled steel are attached to the runners, and bronze matching rings were placed on the casing covers. The control of pressures on the upper and lower faces of the runner and also the resultant hydraulic uplift for relief of the thrust-bearing load is automatic.

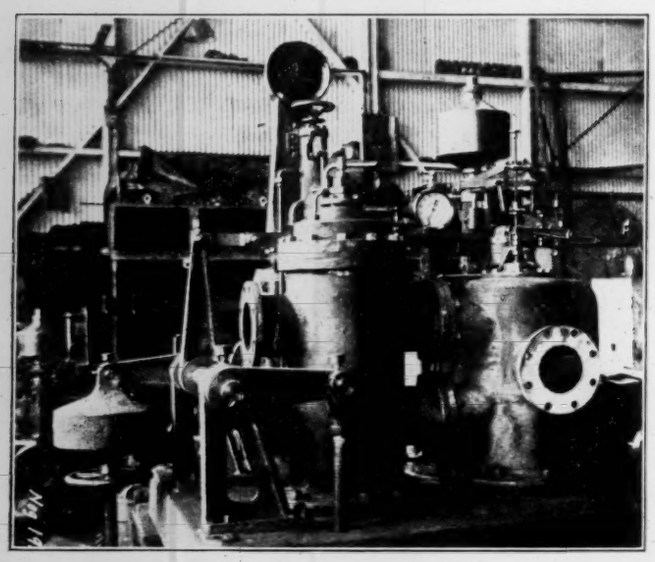

Fig. 3 Shop Assembly of Governor

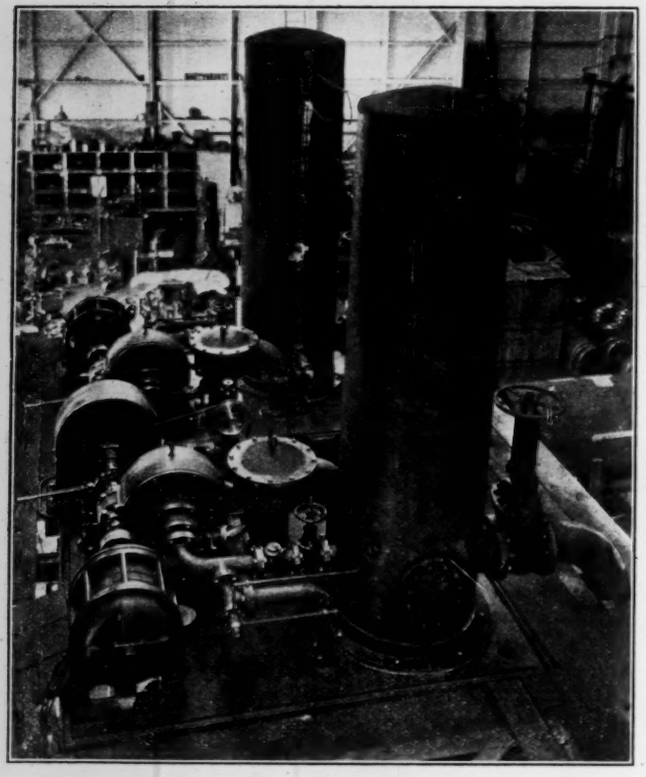

Fig. 4 Shows Assembling of Pumping Equipment, etc., for Oil-Pressure System Note Between the Two Motors the Impulse Wheel Which Takes Over the Pumping Load in Case of Momentary Failure of the Motors

Further, when operating turbines under heads as high as used at Kern River No. 3 plant it is absolutely necessary that a thoroughly reliable and efficient brake be installed as a part of the equipment. It takes very little water at such high heads to develop sufficient power to keep the turbine rotating at full speed without load. Then if the guide vanes become worn and possibly slightly bent through closing on some obstruction, it is conceivable that enough leakage would occur actually to prevent closing down with the governor, were no brake available.

The brakes on the turbines of this plant are of the post type lined with a specially made wire-inserted asbestos-stitched fabric. They are hand operated from the main floor. From full speed of 600 r.p.m. the brakes will bring the rotating element to a full stop without undue effort in less than three minutes and in an emergency can be operated much more rapidly.

The governors are of the Pelton vertical-spindle belt-driven floating lever, actuator type taking oil pressure from a central system and delivering it to the servomotors, which are mounted rigidly on the turbine casing. The actuators operate on the open sump system, with enclosed centrifugal elements and dash-pot compensation. The shop assembly of the governor is shown in Fig. 3.

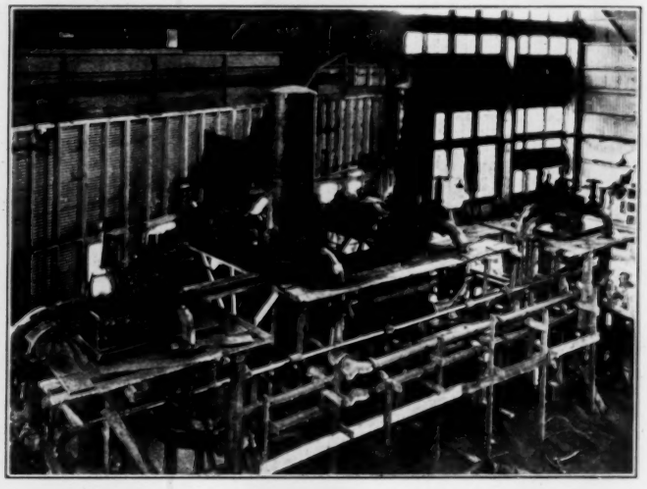

Fig. 5 Complete Shop Assembly of Governor and Oil Pressure System

A mechanical synchroscope and gate-opening indicator makes it possible to synchronize the valve positions in both governor actuator and hand control so that there will be no surging movement of the turbine-gate mechanism when switching from board to governor operation, or vice versa.

The pressure oil system is in duplicate, each side being of sufficient capacity to operate both main turbines at one time. The arrangement as shown in Fig. 4, includes two oil pumps of the Pelton rotary two-stage or series type. Shop assembly of governor and oil-pressure system is shown in Fig. 5.

Normally electric motors are used for operating the pumps. The arrangement is such, however, that if, for any reason the electric motor fails, the nozzle of a water motor automatically opens and the pump continues in service. The pump is thus made to operate continuously. This does not have any bad effect upon the oil however, for, when the pressure in the accumulating tanks reaches a predetermined maximum the pumps are automatically unloaded.

The equipment of the turbine and governors for the most efficient use of the available water supply is unique. About 300 sec. ft. of water is required to supply each turbine unit at full load. The stream flow varies with the season and at times is not sufficient for fully supplying one unit. From this minimum the quantity increases gradually to 600 sec. ft. or more. As there is

no storage available special apparatus was desired for automatically making use of the water supply to best advantage.

For periods when the water is more than sufficient for one unit but not enough for two, a cross connection is made between the turbine and one of the governors takes master control of its turbine, which delivers 60 cycle current on a fluctuating load to the Mt. Whitney system. The remaining turbine is then set in block load delivering its power into the 50 cycle system. By means of the cross connection between the units the master governor automatically sets the load limit on the block load unit so its guide vanes at once move to consume any water rejected by the master machine on load decrease or vice versa. Thus a constant flow equal to the maximum available water supply is made to do useful work instead of being allowed to run to waste over the spillway and the master unit always has available a water supply margin sufficient to take care of load fluctuations which always occur on a governing unit. The cross connection between the turbines makes it possible to use this margin quantity on the block load unit until needed for governing since a call for more water in the master unit will immediately act to decrease the consumption of the block load carrier by an equivalent amount. An adjustment is provided in the cross connection to correct for the variation of turbine gate discharge between the two units and to insure smooth operation in the water transfer. In addition to this cross-

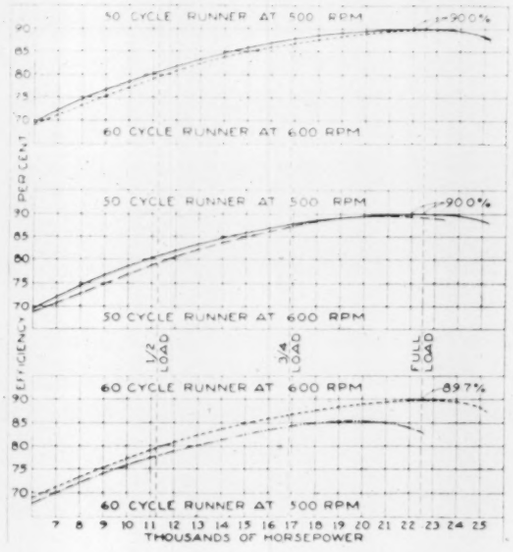
50 CYCLE RUNNER AT 500 RPM
90.0%
60 CYCLE RUNNER AT 600 RPM
50 CYCLE RUNNER AT 500 RPM
90.0%
50 CYCLE RUNNER AT 600 RPM
PER CENT EFFICIENCY
1/2 LOAD
3/4 LOAD
FULL LOAD
60 CYCLE RUNNER AT 600 RPM
89.7%
60 CYCLE RUNNER AT 500 RPM
7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
THOUSANDS OF HORSEPOWER

FIG. 6 EFFICIENCY CURVES OF TURBINES AT TWO SPEEDS AND TWO FREQUENCIES

connection suitable means are provided to take care of seasonal variations in the supply of water.

The units were very carefully tested for efficiency and to determine speed regulation, pressure rise and general conformance to the contract requirement.

Among other things these tests have shown that while there is very little difference in the efficiency of the 50-cycle runner operating at 500 r.p.m. or 600 r.p.m., there is a decided decrease of maximum output when the runner is not operating at its designed speed as illustrated in Fig. 3.

The loss in kilowatt-hours from this alone will make a change of runners advisable if sufficient water for the maximum capacity of the proper runner for as short a time as three weeks may be expected. On the other hand, if the 60-cycle demand is not likely to last that long it will not pay to make the change. This may be easily calculated by balancing the total additional kilowatt-hours produced against the output lost during a twenty-hour shut-down to change runners at the start and a second twenty-hour interval to change back again at the end of the run.

The curves show efficiencies of the 60-cycle, 600 r.p.m. runner operating at both normal speed and at 500 r.p.m. for 50-cycle generation. A marked difference in results is obtained. This is accounted for by the distortion in entrance and discharge angles as well as the increased distance between the ends of the guide vanes and the entrance of the runner.

The water is taken from the river by means of a concrete diversion dam of ogee form. After passing through an inclined grizzly, and two motor-operated head gates, it is carried by concrete flume for about one half mile to a double-compartment, reinforced-concrete sand-settling basin 400 ft. long by 60 ft. wide by 20 ft. deep. One compartment may be sluiced of sediment while the other is in use.

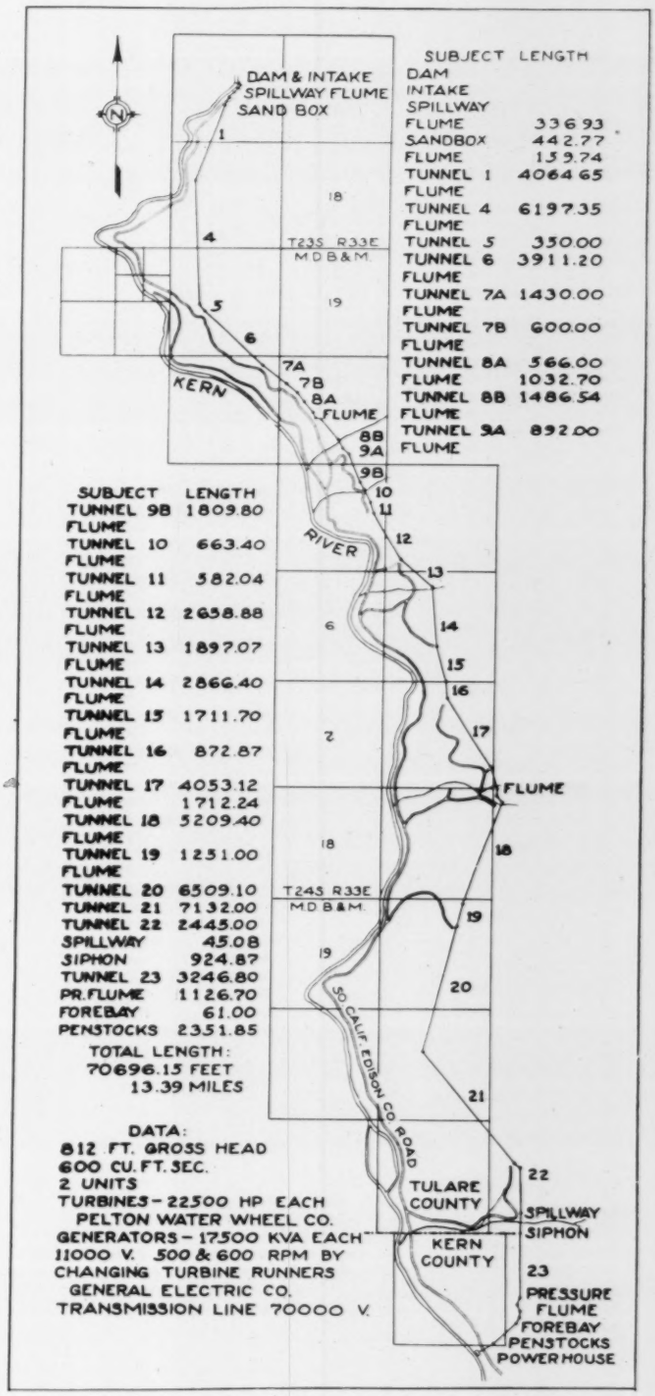

FIG. 7 PLAN OF POWER-WATER SUPPLY SYSTEM

From the sand-box to the surge-chamber, a distance of about 11½ miles, the conduit is mainly in tunnel, alternating with short stretches of concrete flume. The surge chamber is of reinforced concrete. A steel pipe 2520 ft. long, 84 in. in diameter at the surge-chamber, tapering to 60 in. at the power house, leads to each of the two turbines.

REDUCTION OF FUEL WASTES IN THE STEEL INDUSTRY

(Continued from page 238)

either by itself or in conjunction with by-product gas, and has been used for steam production either as an auxiliary fuel on blast-furnace boilers or by itself, and its use has been proposed to heat by-product ovens, thus releasing additional gas otherwise required for heating the ovens.

Heat Balance

Table 1 gives an example of the approximate heat balance of one ton of pig iron as used in the steel plant, using average figures, and based on an average coke consumption in the blast furnace of 2500 lb. of coke per ton of product.

TABLE 1 HEAT BALANCE FOR MANUFACTURE OF ONE TON OF PIG IRON

From the coke plant delivering one ton of coke there result the following fuel by-products for consumption in the steel plant after the heat and power requirements of the by-product plant have been met:

12 gal. tar at 162,500 B.t.u. per gal., B.t.u.	1,950,000	
30 lb. of coke breeze at 12,000 B.t.u. per lb., B.t.u.	360,000	
10,000 cu. ft. gas at 500 B.t.u. per cu. ft. (net value), B.t.u.	5,000,000	
Total per net ton coke		7,310,000
Heat available per ton pig iron	B.t.u.	B.t.u.
In tar from by-product plant	2,435,000	
In coke breeze from by-product plant	450,000	
In surplus gas	6,250,000	
Surplus from by-product plant		9,135,000
In blast furnace gas		19,635,000
Required for blast heating	5,000,000	
Required for blowing equipment	4,400,000	
Required for blast-furnace operation	1,000,000	
Required for total blast furnaces		10,400,000
Surplus from blast furnace plant		9,235,000
Total heat energy from by-products		18,370,000
Heat required for steel plant		
Open hearth (pig iron to ingots)		
Melting (approx.)	7,000,000	
Power, 25 kw. at 25,000 B.t.u. per kw-hr.	625,000	
Total heat consumption		7,625,000
Roughing Mill		
Heating (approx.)	2,000,000	
Power, 50 kw-hr.	1,250,000	
Total		3,250,000
Finishing Mill		
Heating (approx.)	4,000,000	
Power, 100 kw-hr.	2,500,000	
Total for finishing		6,500,000
Total heating requirements	13,000,000	
Total power requirements	4,375,000	
Total		17,375,000

Necessity of Heat Conservation

From Table 1 it will be seen that the total heat from the by-products of a ton of pig iron is more than sufficient to finish the average ton of steel, but upon inspection of the table it will be found that the heating requirements have not been met from tar and by-product gas, while the average power requirements are more than met from blast-furnace gas and coke breeze.

It therefore becomes very desirable to reduce the heating requirements for production of steel by using more efficient heating furnaces, and to conserve all possible heat by charging hot steel into the soaking pit and reheating furnaces, in order to reduce the quantity of fuel required for supplementary heating.

The production of gas at the by-product plant is practically uniform, while the consumption at the steel plant is variable and as a result the gas pressure at the steel plant (usually some distance away from the by-product plant) is variable. As gas holders of sufficient capacity to absorb the fluctuations have not been found advisable it becomes necessary to schedule the use of gas by consuming departments in order partially to equalize the consumption. In many cases it is advisable to use by-product gas under boilers (although it is more valuable for other purposes) in order to prevent or reduce its waste, as it is easier to change from gas to coal on boilers than to fire up producers.

One of the most important problems of the steel plant manager and engineer is so to regulate the production and consumption of the various fuels occurring as a by-product of steel-plant manufacture that the consumption of raw coal in producers or under boilers that would otherwise be sent to the by-product plant is a minimum, for the reason that the by-products from the coal, coked in the by-product plant, usually exceed any possible return as fuel.

COTTON-GINNING MACHINERY

(Continued from page 236)

largest size condenser. This is equivalent to a screen exposure when running, of from 2 sq. ft. down to 1 sq. ft. per saw per minute. The peripheral speed of the doffing rollers should be the same as that of the screen drum. From the condenser the lint cotton is delivered by the doffing rollers to the lint slide, thence into the press box.

The Cotton-Ginning Process

The seed cotton is brought to the cotton-gin plant in quantities of 1600 lb. when clean-picked cotton and of 2000 lb. to 2200 lb. when gathered or grabbed cotton. When ginned there will be a finished bale weighing about 500 lb., and 1050 lb. of cotton seed; the remainder is refuse, as trash, hulls, dirt and other foreign substances. The seed cotton is usually hauled in wagons, from which it is sucked off through a telescope by means of air-suction steel-plate centrifugal, fans operating at a blast-wheel peripheral speed

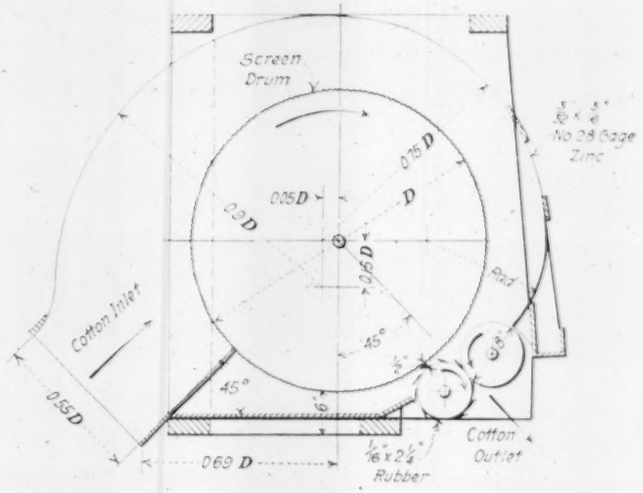

Fig. 15 Condenser

of 11,000 to 13,000 ft. per min., and producing a vacuum of 14 to 16 in. of water. In the course of its travel the cotton is carried through a cleaner where it is agitated on a screen to remove the foreign substances; thence it passes to the elevating system where the air is separated from it, and is dropped into the gin feeders, where further cleaning is performed. The cotton is next delivered to the gin in such quantity as will not gorge the roll box but will be sufficient to insure a nice, moderately soft, pliable ginning roll. If the cotton is clean-picked it can be delivered direct to the ginning roll in a plain gin; but if gathered or grabbed it will contain hulls, etc., and should be delivered to a huller roll box.

The seed fall from the roll box down into seed conveyor, from which they are delivered to the customer's seed box or into a seed storage house. The hulls, trash and foreign substances are conveyed outside of the gin house to the boiler room for fuel—that is, that part that is combustible—or hauled off to be used later as fertilizer. The motes are also conveyed out and in some instances used for low-grade fiber stock. The lint cotton passes from the gin to the lint flue and then to the condenser, where it is separated from the air and formed into a bat. It is then delivered into the press box for packing, wrapping and pressing, ready for the market, and after marketing is compressed and rewrapped before being export.

Textile Machinery to be Discussed at A.S.M.E Meeting

At the Atlanta Spring Meeting, May 8–11, of The American Society of Mechanical Engineers, the Textile Division will hold two joint sessions with the Machine Shop Division at which six papers on textile machinery will be presented. In addition to Mr. Gillespie's paper, printed above, the papers will deal with weaving, spinning, and carding machinery.

The Moody Ejector Turbine

Particulars of a Turbine for Low-Head Installations Which Delivers the Rated Horsepower at Maximum Efficiency When the Head is a Maximum, and also Maintains the Output When Head is Reduced at Flood Periods

By S. LOGAN KERR,[1] PHILADELPHIA, PA.

ONE of the greatest difficulties met in the operation of low-head hydroelectric power plants is the reduction of capacity during flood periods. It is usually impossible, owing to the nature of the surrounding country and the enormous quantity of water required, to provide storage reservoirs to such an extent that all excess water flowing during these flood periods can be entrained and used when the stream flow is below normal. Some regulation, of course, is effected in a few instances, but for the most part there is sufficient only to carry the plant over the daily peak.

Where the storage is thus limited, owing to the character of the country surrounding the plant, the flow of water during the flood season is much greater than is required by the turbines. This excess is therefore wasted over the dam, and in addition causes the tail water to rise in level.

Since the turbine operates upon the difference in level of the head and tail waters, should these levels vary the same amount, then this difference or head would be constant. Usually this is not the case, for with a given rise in level of the water going over the dam, the rise in the level of the tail water is greater, thus decreasing the net head. This effect is illustrated in Fig. 1. The head at low water is evidently much greater than at high water as reference to this sketch will show. The line intermediate between the two extremes shows the effect when the level of the head water is increased by a small amount. It is evident even in this case that the net head is decreased.

Since the horsepower of the turbine varies as the three-halves power of the head acting upon it, the output of the station is decreased in the same ratio, but as the operation is of necessity at constant speed, the efficiency may be less as well, depending upon the characteristics of the wheel, causing a still further decrease in capacity. Thus the resultant loss in power may be very great, depending upon the rate of off-flow of the tail water, which in turn is dependent upon the character of the stream bed below the dam.

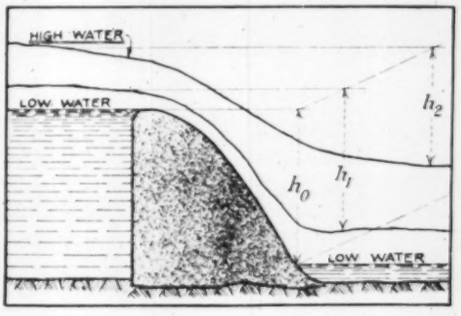

FIG. 1 SKETCH SHOWING DECREASE IN EFFECTIVE HEAD DURING PERIODS OF HIGH WATER

As was stated above, in low-head plants where the quantity of water required to generate a given amount of power is large, the storage facilities are usually small. Therefore the turbine should be designed to give maximum efficiency at rated output when the head is a maximum, for at this time water is scarce and economical operation is imperative.

Due to their inherent characteristics, the high- or relatively high-speed wheels used in low-head work give as a rule a rather narrow operating range at maximum efficiency, and a small overload capacity beyond this point of maximum efficiency. To design a turbine, then, that would deliver the required output under a reduced head would be inadvisable, for this same turbine would not operate at best efficiency when delivering rated horsepower under the higher normal head resulting from low water.

This is illustrated in Fig. 2 where the turbine is designed to deliver 100 per cent of rating at 75 per cent of normal head. When this same turbine is operated under 100 per cent head, its capacity is increased to 140 per cent of rating; but as only 100 per cent is required, it is evident that the efficiency will be several per cent less than the maximum. This method of meeting the problem would be wasteful from the standpoint of economy of operation at maximum-head conditions.

Another method would be to install a number of additional units

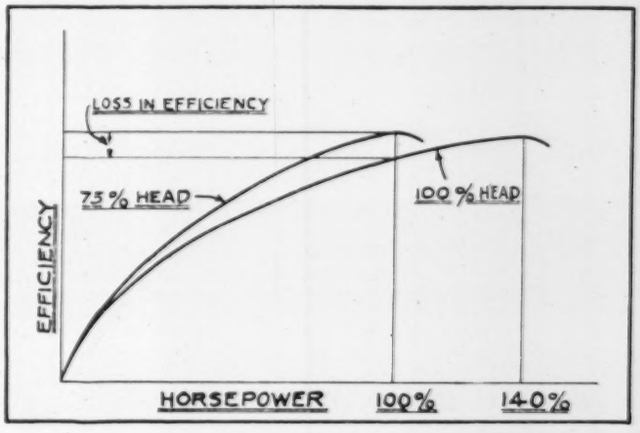

FIG. 2 SKETCH SHOWING DISADVANTAGE OF DESIGNING TURBINE FOR MAXIMUM EFFICIENCY AT THE MINIMUM HEAD CONDITIONS

that could be placed in operation when the capacity of the plant was cut down at high water. Such a plant would require a much greater expenditure of money in the first cost, which could render a return on the investment for a short period only each year. This, then, is a possible solution, but the resultant fixed charges upon the plant would be so great, in many cases, as to make the cost of power prohibitive.

There remains this problem: to design a turbine that will operate as economically as possible at times when the available supply of water is small, and yet develop normal rated power when the overabundance of water decreases the effective head.

THE MOODY EJECTOR TURBINE

A turbine designed to meet these requirements has been developed by Mr. Lewis F. Moody. The apparatus consists of a turbine of the normal type designed to operate at maximum efficiency under the average head prevailing at times of low water, but at the top of the draft tube, just below the runner, an annular opening is made in the wall of the tube, the amount of this opening being controlled by a cylinder gate.

When the turbine is operating normally, this gate is closed and the contour of the draft tube is unchanged, as shown in Fig. 3. When the head falls off due to the rise of the tail water, this gate is opened slightly, allowing a jet of water at high velocity to enter the draft tube without first passing through the runner. This case is shown in Fig. 4. The action of the jet, expressed simply, is to "pull" more water through the runner and hence to increase the horsepower output of the turbine.

The jet actually creates an additional suction head that compensates for the loss in the difference in level between the head and tail water. So that the turbine is in reality operating under a

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Extracts from a thesis submitted to the University of Pennsylvania for the degree of Bachelor of Science in Mechanical Engineering by the author in June, 1921. Awarded A.S.M.E. Junior Prize for the best paper during the year 1921. All papers are subject to revision.

head made up of two parts: first, the effective head measured as the difference in levels of the head and tail water (less, of course, the frictional head in the water passages); and second, the "suction head" produced by the action of the jet of water admitted below the runner. For this reason the device has been called an "ejector turbine."

Tests Made on the Turbine

The apparatus described above was set up and tested in the I. P. Morris Experimental Laboratory of the William Cramp & Sons Ship & Engine Building Company in Philadelphia. The turbine was equipped with guide vanes placed in the ejector. The function of these vanes, which will be called ejector vanes hereafter in order to avoid confusing them with the guide vanes and

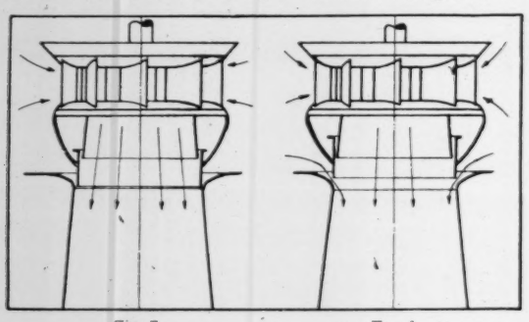

Fig. 3 Fig. 4

Figs. 3 and 4 Sketches Respectively Showing the Ejector Closed and Open

speed ring vanes of the turbine proper, is to give the water entering the ejector an initial whirl, so that there will be a minimum amount of interference with the water coming off the runner.

In the first series of tests (A1 to A6) model runner No. 55 was used. This runner (16 in. in diameter at the throat) is of the mixed-flow type and has a specific speed of 84.4 at best ϕ. The symbol ϕ represents the coefficient of peripheral velocity or the ratio of the linear velocity of a point on the runner to the theoretical spouting velocity of the water under the operating head. This ratio may be based on any one of several diameters, but in this article, the ϕ based on the diameter at the throat of the runner is meant. The values of specific speed (N_s) are all given in the English foot-pound system.

The first test (A1) was made at the maximum opening of the ejector (3.155 in.). The measurement of these openings was made by taking the average of a series of readings scaled off at various points around the ejector. A series of ϕ-Efficiency and ϕ-Horsepower curves under 1 ft. head and 1 ft. throat diameter was drawn for each test and the performance curves calculated from these. Description of the necessary calculations and of the method employed in testing are given in appendices to the complete paper.

A series of tests was made, each with a decreasing opening of the ejector until a point of 0.824 in. was reached. The next test (A6) was made with the ejector gate entirely closed.

However, this test did not give as good efficiency as was previously secured with the same runner and draft tube in another test. Upon investigation, it was found that the cylinder gate of the ejector did not seat properly upon the lower ring and that a small opening was left on one side of the turbine, thus admitting a small amount of water on about one-third of the periphery of the ejector. It is of interest to note that for any given gate opening of the turbine, although the efficiency was reduced about five per cent from that previously obtained, yet there resulted a slight increase in horsepower with even this small ejector opening.

In plotting performance curves of the values in test No. A6 the test efficiencies were stepped up to correspond with those obtained in previous tests. This is permissible, for in tests Nos. B6 and C2 made with runner No. 65, the ejector was calked tight to eliminate this difficulty and to correspond to the more perfect construction that would be found in large units built for commercial purposes. The results in these tests gave efficiencies that checked very closely with those obtained when the same runner was tested without the ejector installed.

Another series of tests was made using runner No. 65 in place of runner No. 55. This runner (16.25 in. in diameter at the throat) is of the "diagonal-flow" type and has a specific speed of approximately 100. This series of tests (B1 to B6) was run with varying openings of the ejector, but the angle of the ejector vanes was changed to conform with the variation in the theoretical value of the whirling component of the water leaving the runner with the increase in specific speed.

When this series had been run, it was thought advisable to test runner No. 65 with the ejector vanes removed in order to study the effect of the ejector water without this initial whirl.

Investigation of the Influence of Ejector upon the Flow in Draft Tube

It was desired as well to see the effect that the water injected into the draft tube through the ejector would have upon the normal flow of water coming off the runner. In order to measure the velocity of water in the draft tube it is necessary to know the direction that it takes, since the flow is not the same as in a pipe line or canal, but moves with a whirling motion and follows a path similar to a helix in form. The steepness of this helix depends upon a great number of conditions, principal among which are the type of runner, the speed, and the load under which the turbine is operating.

An instrument was developed by the writer with the cooperation of the staff in charge of experimental work of the I. P. Morris Department especially for this test to measure the velocity and direction of flow in the draft tube. The apparatus, because of its form and the use for which it was designed, has been called a "pitot velometer."

The pitot velometer consists of a double pitot tube similar to the "Pitometer" with symmetrical openings 180 deg. apart. The head was arranged so the maximum dimension would pass through a hole the size of the outside diameter of standard $^3/_8$-in. pipe. The whole head, rod, and end connections are free to rotate and move in and out from the center line of the draft tube. A pointer

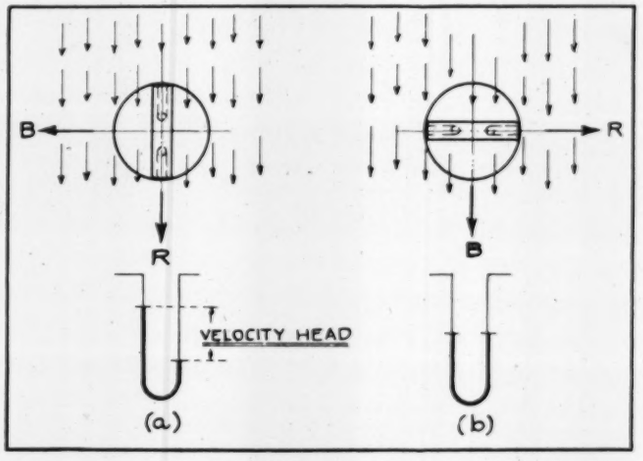

Fig. 5 Positions of Pitot Velometer (*a*) when Reading Velocity and (*b*) when Reading Deviation from Vertical
(R indicates red pointer; B, black pointer.)

is fixed on the outer end of the instrument, and a dial hung on a ball bearing and weighted to keep the zero of the scale vertical showed the position of the center line of the openings in the head.

These two openings were attached to the legs of a differential gage filled with mercury and when the head was turned to a position so that the two openings were in a line with the flow of the water, the velocity head was indicated on the gage. When the rod was rotated through 90 deg., the center line through the openings was perpendicular to the flow, and the two legs of the gage stood at the same level. It was found that the apparatus was very much more sensitive in this position than with the openings in line with the flow, and that the angle of deviation from the vertical could be more accurately read.

For this reason two pointers were attached to the rod; one painted black was set at right angles to the line through the center

of the openings, and the other painted red set parallel with this line.

In taking a reading, the rod was set at the desired point on the diameter of the draft tube and rotated until the two legs of the differential gage stood equal, this position is shown in Fig. 5 (*b*). The reading of the deviation was recorded as shown by the black pointer. The red pointer was then brought to this point, automatically placing the openings in line with the flow and the velocity read by the difference in levels of the mercury columns. This position is shown in Fig. 5 (*a*). The scale of the dial was graduated in degrees and half-degrees. It was possible to measure the deviation of this velocity from the vertical accurately to within a single degree.

The scale of the mercury gage was graduated to read zero when the two legs were equal; below this line the scale was laid off in inches of mercury. Above the zero line the scale was so arranged to give the velocity directly in feet per second. The pitot velometer was located approximately 24 inches below the horizontal center line of the turbine.

The diameter of the draft tube at the point where the instrument was installed was 19¾ in., but as the flow was investigated on one side only of the tube, the horizontal motion of the head was one-half of the diameter or 9⅞ in.

Readings were taken at each even inch from the vertical center line up to and including a point at a radius of 9 in., thus making a total of ten readings for one complete traverse.

It was thought best, due to the time required (seven to ten minutes) for one complete traverse of the draft tube, with ten readings each of velocity and angle of deviation from the vertical, to take traverses only at points within the possible operating range of the turbine, or of a turbine of this type installed in a power plant.

Since the limits of maximum and minimum ϕ for this range could easily be determined, three traverses were made for each gate opening at points within these limits. A large number of traverses were made, two examples of which are shown in Figs. 14 and 15.

Two tests were made, the first (C1) was run with the ejector

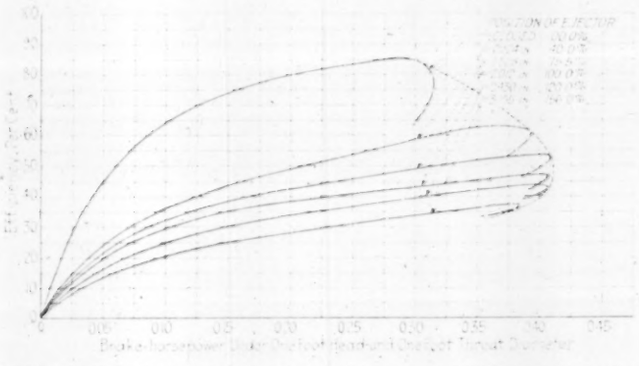

FIG. 6 CURVES SHOWING OPERATION AT NORMAL ϕ WITH VARYING EJECTOR OPENINGS AND EJECTOR VANES IN PLACE; RUNNER NO. 55

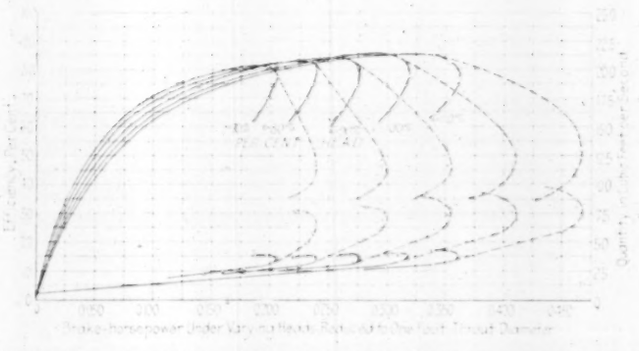

FIG. 7 CURVES OF HORSEPOWER, EFFICIENCY AND QUANTITY FOR RUNNER NO. 55 UNDER VARYING HEADS

Normal Operation Indicated by Solid Lines and Operation with Ejector by Broken Lines

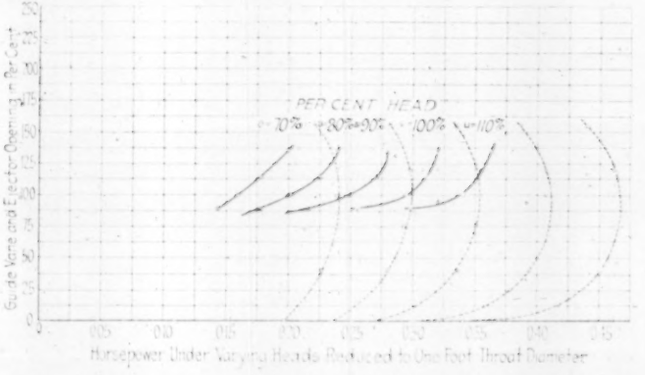

FIG. 8 CURVES OF HORSEPOWER FOR VARYING HEADS FOR DIFFERENT GATE (SOLID LINES) AND EJECTOR (BROKEN) OPENINGS, RUNNER NO. 55

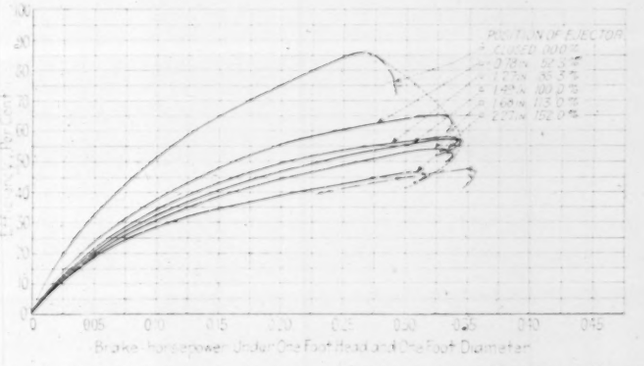

FIG. 9 CURVES SHOWING OPERATION AT NORMAL ϕ WITH VARYING EJECTOR OPENINGS AND EJECTOR VANES IN PLACE; RUNNER NO. 65; ONE CURVE WITH VANES REMOVED

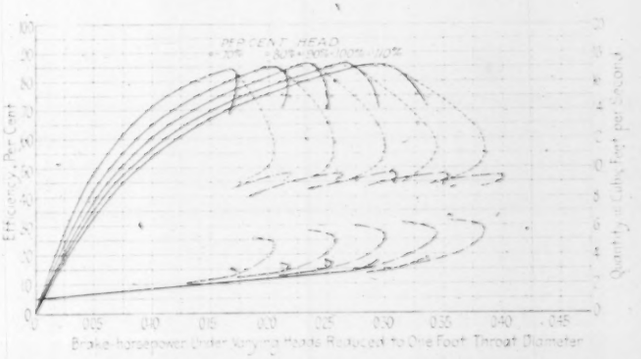

FIG. 10 CURVES OF HORSEPOWER, EFFICIENCY AND QUANTITY FOR RUNNER NO. 65 UNDER VARYING HEADS

Normal Operation Indicated by Solid Lines and Operation with Ejector by Broken Lines

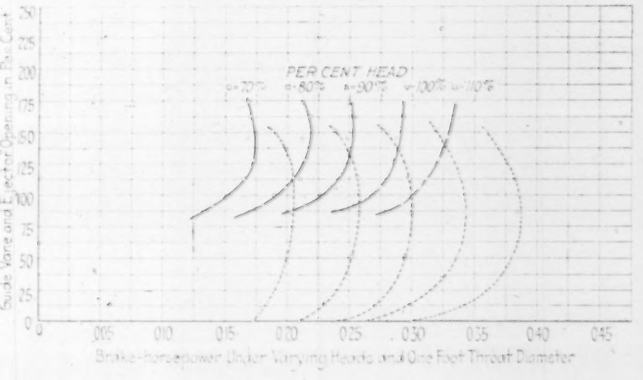

FIG. 11 CURVES OF HORSEPOWER FOR VARYING HEADS FOR DIFFERENT GATE (SOLID LINES) AND EJECTOR (BROKEN LINES) OPENINGS, RUNNER NO. 65

open about one and one-half inches, the second (C2) was made with the ejector closed and caulked, to have, as a basis of comparison, the flow of water coming from the runner uninfluenced by the ejector water.

Results of Tests

In order to show the increase in horsepower obtained by use of the ejector over that normally delivered by the turbine, a series of performance curves was drawn with efficiencies as ordinates and horsepower under 1 ft. head reduced to 1 ft. throat diameter as abscissae. These curves were drawn for each of the tests in the first and second series. The envelope of these curves was then drawn in and is taken as the performance of the turbine and ejector combined.

It may be seen from Figs. 6 and 9 that a considerable increase over the rated output is obtained by the use of the ejector. This increase is 36.7 per cent based on rating of 0.300 hp. under 1 ft. head and 1 ft. throat diameter for runner No. 55 and 30.0 per cent for runner No. 65 equipped with vanes in the ejector. Based on the maximum power obtainable these values are 34.5 per cent for runner No. 55 and 17.0 per cent for runner No. 65.

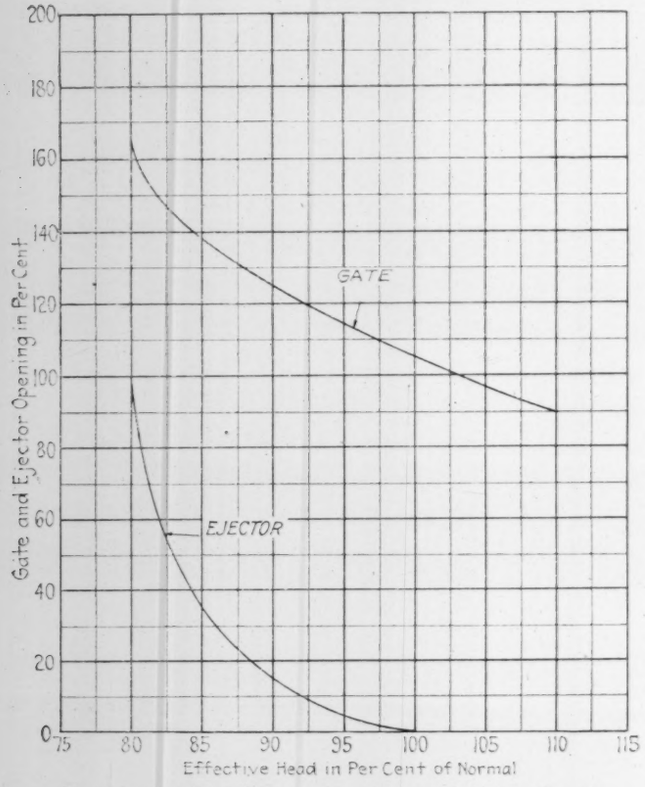

Fig. 12 Constant-Horsepower Curves, Runner No. 55

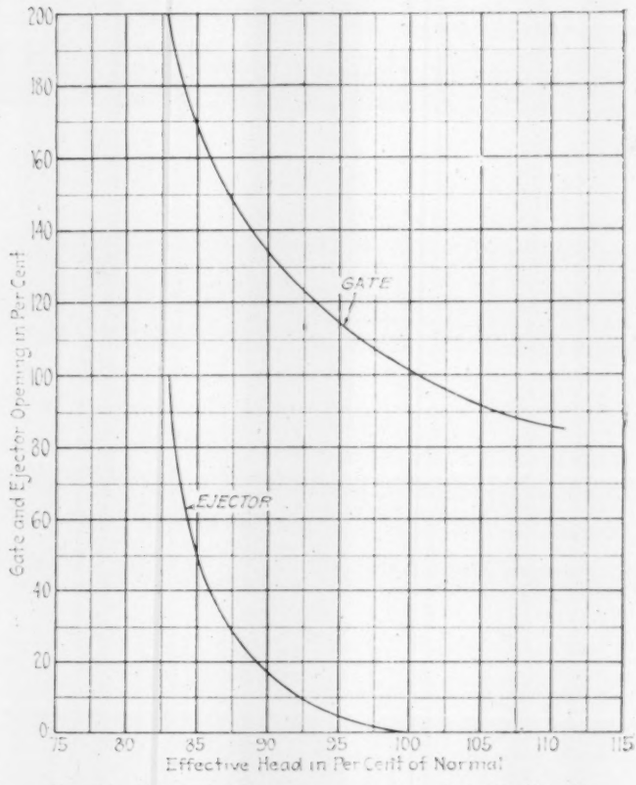

Fig. 13 Constant-Horsepower Curves, Runner No. 65

A second set of curves (Figs. 7 and 10) was plotted showing the performance of the turbine and ejector under varying heads, each curve consisting of two parts, the normal performance curve and the envelope of the several ejector performance curves. Curves are plotted for 70, 80, 90, 100 and 110 per cent of normal head, the latter being taken as 1 ft. to have a standard for a basis of comparison. Along with these curves have also been plotted curves of horsepower against quantity.

Guide vane and ejector openings have also been plotted against horsepower and appear as Figs. 8 and 11. In all of these results there has been no allowance made for the increased frictional losses in the water passages leading up to the turbine, since the model tested was of the open-flume type. Therefore the losses resulting from the increase in quantity flowing must be calculated for each individual case where the ejector is to be applied. It should be noted that the results include some of the losses, namely, the losses within the turbine and the losses in the draft tube, but not the losses that would occur in the penstock or the casing. It is probable that these will not be excessively large, since low-head installations have relatively short penstocks which are usually integral with the dam.

It may be noted that with runner No. 55, normal rated horsepower can be maintained under 80 per cent head and under 83 per cent head with runner No. 65, when both are equipped with guide vanes in the ejector.

From the curves of horsepower, gate and ejector opening, another series of curves was obtained (Figs. 12 and 13). These might be called very appropriately "Constant-Horsepower Curves." The ordinates are per cent ejector or gate opening and the abscissae are per cent normal head. If, therefore, the per cent of normal head under which the turbine is operating is known, by finding the points where the gate and ejector opening curves cross this line, the proper setting of the turbine and ejector gates that will maintain rated capacity may be read. These curves are plotted for each of the two main series of tests.

In Fig. 10 (curves of horsepower and efficiency under varying heads for runner No. 65) a set of small curves, one for each 10 per cent of normal head from 70 to 110 per cent are drawn for comparison with the other performance curves. These are the results of test No. C1 (runner No. 65 with ejector vanes removed), and it may be seen that there is a slight numerical increase in horsepower over that obtained with the vanes in place, but judging from the position of these curves with relation to the others and to the shape of the envelope of the curves of varying ejector openings, it is reasonable to suppose that the maximum increase obtainable with the ejector vanes removed is much greater than the actual numerical difference would indicate. It would seem that the turbine was operating on the drowned part of the envelope.

The explanation of this is probably that the increase in area of the opening with the vanes removed was greater than that required to secure maximum horsepower, and had the effect of drowning the turbine. If the opening had been smaller, the actual maximum horsepower obtainable with the vanes removed would have been secured.

In all the foregoing tests the turbine was equipped with the Moody spreading draft tube, and it is reasonable to suppose that the results are considerably better than could have been obtained with a straight or curved tube of another form. This statement is borne out by recent tests comparing the performance of various draft tubes.

Conclusions Regarding Flow in the Draft Tube

When the turbine is operating at normal ϕ, the whirling component of the water coming off the runner is in the direction of rotation of the turbine. In all readings of the deviation of this velocity from the vertical, this direction is taken as positive.

From curves of traverses made both with and without the ejector open, it has been found that if the turbine is overgated this whirl may become negative, due to the excess of water passing through the runner. At overload the runner is not moving in the same relation to the water as at normal operation, and the whirl under these conditions may become negative at all but very large values of ϕ. When the turbine is operating at high values of ϕ, the whirl is positive, or nearly so, even though the turbine is overgated.

From comparisons of traverses made with and without the ejector open, the following general conclusions may be drawn (see Figs. 14 and 15):

1 The characteristic form of the curve of the angle of deviation from the vertical was not influenced by the water from the ejector.

2 The velocity of the water at the outer portion of the draft tube was increased by the action of the ejector water over values obtained without the ejector open.

3 The ejector had little or no effect upon the flow of water coming from the runner up to and including a point about 6½ in. from the center line of the draft tube, or in other words, the inner two-thirds of the draft tube was not affected by the ejector.

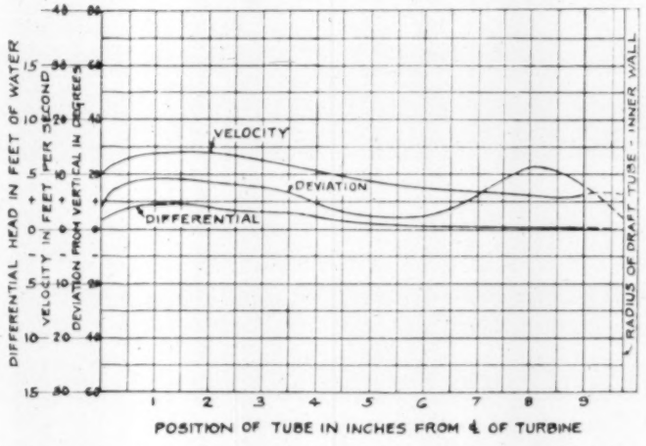
DIFFERENTIAL HEAD IN FEET OF WATER
VELOCITY IN FEET PER SECOND
DEVIATION FROM VERTICAL IN DEGREES
VELOCITY
DEVIATION
DIFFERENTIAL
RADIUS OF DRAFT TUBE - INNER WALL
POSITION OF TUBE IN INCHES FROM ℄ OF TURBINE

Fig. 14 Flow in Draft Tube, Ejector Closed; Gate Opening 40 Per Cent; ϕ = 1.262; Runner No. 65

4 The action of the runner influenced the direction of the flow of water issuing from the ejector, and not vice versa.

By referring to the curves plotted from results of these traverses, it may be seen that the angle of whirl is very nearly the same regardless of whether the ejector is open or not, but that the velocity of the water in the outer third of the draft tube is increased considerably over that with the ejector closed.

Summary

As was stated in the introduction, the need for the ejector type of turbine is felt only in low-head installations where the reduction in head due to flood periods reduces the capacity of the plant to an appreciable extent.

It is obvious that instead of wasting the excess water that would ordinarily pass over the dam during these periods, the ejector uses this same water to counteract the reduction of the effective head and to maintain the rated output of the plant.

While it is imperative that the turbine operate at maximum efficiency when the head is a maximum and water is scarce, it is also true that economical operation is secondary to the maintenance of rated output when there is so great an overabundance of water that the capacity is reduced.

The Moody ejector turbine meets these requirements, for under design conditions it operates as a normal turbine delivering rated horsepower at maximum efficiency; but when the head is reduced at flood periods, the cylinder gate on the ejector is opened and the output is maintained.

This turbine also finds its application, where stream flow and storage conditions permit, in carrying peak loads. At this time the ejector would have the effect as illustrated in the curves of horsepower and efficiency under constant head (Figs. 6 and 9). The maximum possible horsepower that can be obtained is that indicated by the envelope of the several ejector curves. The turbines would therefore be designed to deliver rated power for the average load and rely upon the ejector to carry the peaks. The application of the ejector to these conditions could only be

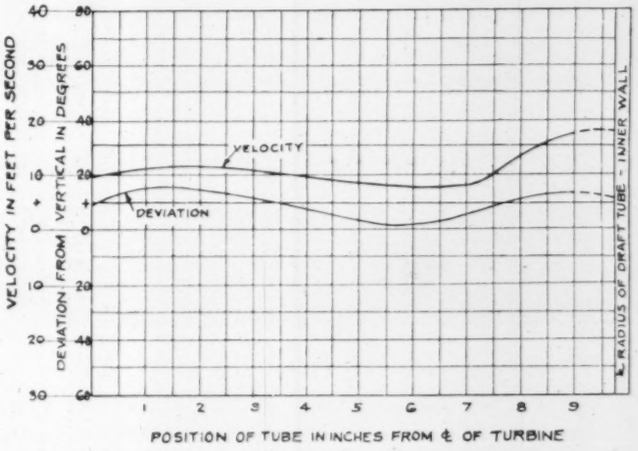
VELOCITY IN FEET PER SECOND
DEVIATION FROM VERTICAL IN DEGREES
VELOCITY
DEVIATION
RADIUS OF DRAFT TUBE - INNER WALL
POSITION OF TUBE IN INCHES FROM ℄ OF TURBINE

Fig. 15 Flow in Draft Tube, Ejector Open 1.54 in.; Gate Opening 40 Per Cent; ϕ = 1.306; Runner No. 65

effected where the peak loads could be accurately estimated in advance.

In conclusion, the Moody ejector turbine finds its principal application in low-head installations where the effective head is reduced by flood conditions and great fluctuations occur in the stream flow between high and low water.

Public Conference on Business Training of the Engineer

The United States Commissioner of Education is calling a second public conference on commercial engineering on behalf of a committee on commercial engineering appointed by him to investigate business training of engineers and engineering training for students of business.

The conference will be held May 1 and 2 at the Carnegie Institute of Technology in Pittsburgh. President Arthur Hamerschlag of this institution is a member of the committee which is composed of prominent deans of schools of engineering, and of commerce in our larger universities, and of engineers and business men who are nationally known for their interest in the reduction of the costs of production, distribution, transportation, etc., through better training in schools and colleges of the personnel of industry and commerce.

The conference will be open to the public. Invitations to appoint delegates to the Pittsburgh Conference, however, will be sent by the Commissioner of Education to commercial and trade organizations, engineering and scientific societies, educational institutions and other groups as well as to prominent individuals.

Owing to the timeliness of the subject, the conference in Pittsburgh will even have greater national significance than the first public conference on this question, which was held in Washington two and one-half years ago under the direction of this committee on commercial engineering of which Dr. Glen Levin Swiggett of the Bureau of Education is chairman.

Outstanding topics at the Pittsburgh Conference will deal with the new problems that have recently arisen in modern industries, the solution of which demands a more scientific approach to include job analyses and personnel specifications and a translation of these for use in our engineering and commerce schools; and with the training of the engineer for a better understanding of problems of community development.

Test Code for Hydraulic Power Plants and Their Equipment

Preliminary Draft of the Sixth in the Series of Nineteen Test Codes Being Formulated by the A.S.M.E. Committee on Power Test Codes

BY action of the Council of The American Society of Mechanical Engineers at its meeting in December, 1917 a Joint Committee organized for the purpose of revising the A.S.M.E. Test Code on Water Wheels was approved. Since that time a Committee of twelve and recently thirteen specialists in Hydraulics have worked diligently at this revision. These men represented respectively the American Society of Civil Engineers, the American Institute of Electrical Engineers, the National Electric Light Association, and The American Society of Mechanical Engineers.

In December, 1918, when the enlarged Committee on Power Test Codes was organized and eighteen Individual Committees appointed, by mutual consent, the Committee on Hydraulic Power Plants became No. 18 of this group. The representatives of the four Societies on this Individual Committee are as follows: *A.S.C.E.:* Nathaniel A. Carle, Benjamin F. Groat,[1] and Clemens Herschel; *A.I.E.E.:* Harold W. Buck, Henry S. Putnam, and Philip Torchio; *N.E.L.A.:* Charles M. Allen, Markham Cheever, and J. A. Walls; *A.S.M.E.:* John L. Harper, Raymond D. Johnson, Chester W. Larner, and William F. Uhl. Mr. Uhl is Chairman of the Committee and he will be glad to receive suggestions for corrections and additions to this draft of its Code. These should be addressed to him care of The American Society of Mechanical Engineers.

Introduction

1 Tests of hydraulic power plants relate either to the entire plant, extending from head water to tail water, or to any elementary part or parts of the plant desired. For the purpose of such tests the plant may be divided into six distinct parts, and these may be grouped into three divisions as follows:

Head-Water Division:

(*a*) That lying upstream from the forebay
(*b*) That lying between the forebay and the entrance to the wheel flume or wheel case

Turbine Division:

(*c*) The wheel case and speed ring
(*d*) The runner and guides or nozzles
(*e*)[1] The draft tube. For the purposes of this code the draft tube subdivision shall be considered to be that portion of the hydraulic system extending from the turbine runner to the point of maximum elevation (beyond and exclusive of local surface of disturbances) of the tail water and shall not necessarily terminate at the end of the physical draft tube.

Tail-Water Division:

(*f*) The tail-race.

2 Some of the individual parts noted may be absent from certain classes of hydraulic plants, but all parts of every plant may be logically included in the main divisions given. Figures 1, 2 and 3 illustrate typical conditions.

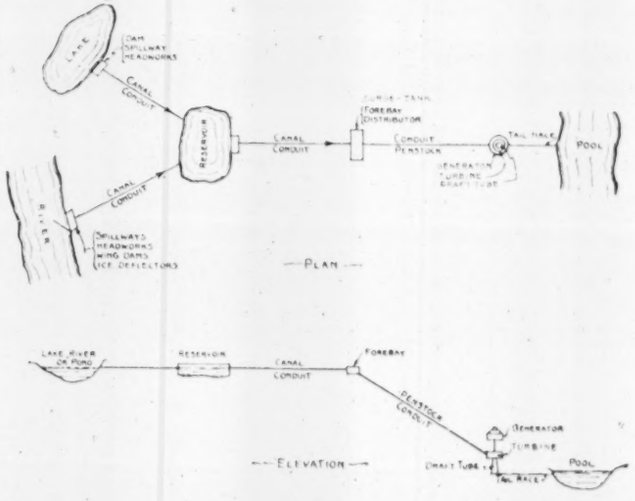

FIG. 1

3 The tests may be either *laboratory* or *field* tests, and as such may cover any part or parts of the plant. They may also be combined *laboratory and field* tests, including tests of a turbine model used as a representative substitute of the existing turbine, being con-

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[1] In signing the report of the Committee Mr. B. F. Groat has made the following reservations.

Par. 1, 2 and 3. I do not agree to the methods of treating the draft tube subdivision in this proposed statement of the code. There is an accepted definite hydraulic theory which may be practically applied to the physical end of a draft tube to determine accurately the full amount of energy being discharged by the draft tube, and any code for testing should set this forth clearly and should limit the amount of energy passing the physical end to reasonable proportions, or, otherwise state, as one of the results of the test, the amount of excess energy discharged in a unit of time which should be entered in the record as a loss of efficiency. This loss of efficiency may be chargeable to the turbine, to the method of its operation, or to the draft tube or other imperfection, or to a combination of these imperfections. It is the province of the test to determine how much this loss in efficiency is. If the loss is within reasonable limits it is passable. If not, it is the province of experts to say how the losses should be divided among the offending elements of the plant.

I cannot agree to the addition of the velocity-head in the tail race to the tail race level because this credits as useful work what otherwise would be a loss. This amount of loss should appear in every report of a test and appear as a loss, whether it be charged against the turbine, the draft tube, or other part of the plant. To add this velocity-head to the tail race level completely buries it from the view.

Par. 1*e*. In my opinion the over-all efficiency of a hydraulic power plant should be measured beyond the point of a maximum elevation of the tail water in the tail race or tail pond so as to obtain the elevation of the water surface therein uninfluenced locally by disturbances emanating unduly, from the plant. When the plant is properly designed the point of maximum elevation in the tail race, or tail pond, will lie substantially in the surface of the surrounding water and there will be no "point of maximum elevation of the tail water." When the test is of the turbine the loss ought to be measured at the physical end of the draft tube and the allowable loss limited as suggested above.

Par. 5*e*. A positive statement should be made that current meters in disturbed water do not adhere to their still-water ratings. This is one of the most certainly established facts of engineering. It should also be stated that the current meter offers one of the most accurate methods of measuring water when care is taken to correct the record by means of ratings in turbulent water. Cup meters are prone to over-register while screw meters are prone to under-register. Surely one of the important offices of the code is to warn the testing engineer of the possible source of error in his instruments and methods.

While I do not want in any way to inject my personal methods into the code unduly, I feel that it may be permissible for me to explain that I have treated a mass of flowing water as a mass of disturbances, these disturbances forming an *aggregate* which may be measured by its effects of one kind or another, say upon the current meter. I have shown by experiment that a certain proportion of transverse motion in turbulent water has, with respect to the longitudinal motion, fixed effect in accelerating a cup meter of given type, and a fixed counter effect in retarding a screw meter of given type, with reference to their still-water ratings no matter whether the transverse disturbances are large or small, frequent or infrequent. That the divergence between the records of the two types of meter is an accurate means of determining the relative amount of turbulence in the water, and an accurate means of correcting the divergent records so as to determine the true velocity.

Par. 18*b* (2). I agree to the definition of "effective head" as in 18*b* only when there are definite and reasonable limitations to the amounts of the losses which are credited to the plant, or part thereof, by a blind application of this definition. If, for example, the division of the plant is a conduit, then the energy leaving should be as large as possible. If it is a turbine, the energy should be as small as possible when leaving. No code for testing hydraulic plants should fail to make clearly expressed distinctions and reasonable allowable limitations in the two cases. A code of testing should supply correct rules for detecting and determining the true losses in the various portions of the plant. It should also state the reasonable limitations to the various losses so that there will be some showing up of excessive losses. Losses at the end of a draft tube should be limited to the head due to 4 feet per second, or some other reasonable amount. Losses in a conduit should be limited by specifications as to hydraulic slope per foot of length of conduit.

Par. 18*b* (2). I do not agree that in the case of an open-flume turbine the velocity of the water coming into the turbine flume should not be considered in determining the effective head. I disagree on grounds similar to those stated above relative to the determination of tail water level. This is a deceptive piece of antiquated engineering that should not be allowed in the code, especially if the combined efficiency of the flume and turbine are to be determined. The velocity-head within the flume should be charged as effective head. Every part of the hydraulic energy that comes to a plant should be charged against that plant in a full statement of the conditions. Nothing is gained by deceiving ourselves into the belief that our works are more efficient than they are.

structed in all respects homologous thereto, and the results being corrected for dissimilar conditions. A laboratory test is one made on apparatus not installed in its final position. A field test is one made on apparatus installed in its permanent location in the plant.

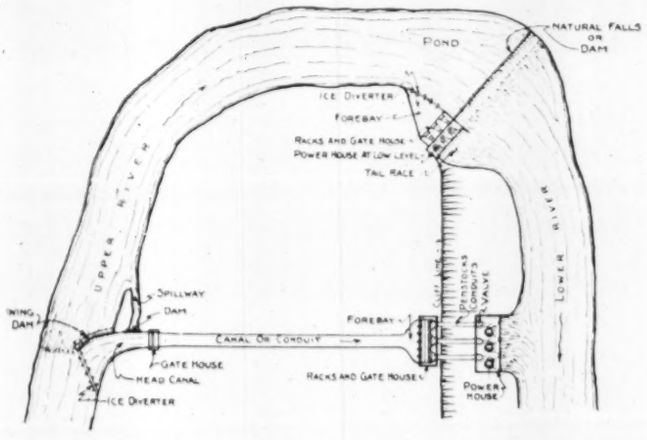
OBJECT

The object of a test made under this Code is primarily the determination of the energy losses in any part or parts of the plant for the purpose of determining the degree of fulfillment of the performance guarantees between builders and users; or for determining how a greater portion of the potential water power available can be converted into useful work; or how combined operation of units or plants may be most effectively conducted.

See Code on "General Instructions."

MEASUREMENTS, WATER

5 On account of the difficulty in making accurate water measurements, every practicable means of checking the quantities measured should be utilized and if feasible more than one method should be employed for comparison with the results of the specified method. The standard method of water measurement is by volume or bulk.



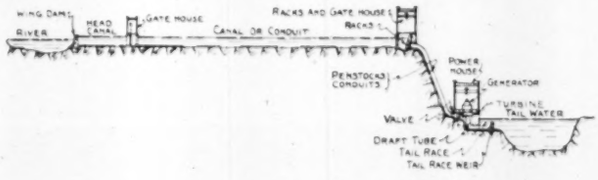


FIG. 2

By comparison with this method the rating of any other method may be determined.

MEASURING WATER IN CLOSED CONDUITS

5a *Venturi Meter.* The venturi meter is adapted for use in conduits in which the flow is not unduly disturbed by bends, sudden changes of section or obstructions near the upstream end of the meter. A commercial meter may be installed as part of the original plant or later by removing a portion of the conduit. If the conduit is large enough to work in, a temporary meter may be constructed of wood or other suitable material inside the conduit.

5b *Pitot Tubes.* Pitot tubes may be employed in conduits where conditions are substantially as described under Par. 5a, but pitot tubes are more sensitive to the disturbing effects of bends, sudden changes of section and obstructions than the venturi meter.

5c *Salt Solution.* The salt solution method may be advantageously employed in conduits where the conditions of flow are too disturbed or the conduits are too short to permit the use of the venturi meter or pitot tubes.

MEASURING WATER IN OPEN CONDUITS

5d *Weir.* This method is adapted for use in open conduits wherever the plant is so arranged as to permit the construction of a weir of proper length with a suitable channel of approach, and provided further that the use of the weir does not change the head on the turbine in excess of the limits provided in Par. 11.

5e[1] *Current Meter.* Current meters may be used in open conduits which are free from serious disturbances such as cross currents and eddies. They are adapted to many cases where the use of the weir is impossible.

5f *Salt Solution.* This method is applicable to practically all conditions of flow in open conduits. It is especially advantageous in cases where the flow is disturbed and may be used under conditions which would not permit the use of current meters or a weir.

MEASURING WATER—SPECIAL METHODS

5g *Special Methods.* The following methods or means employed for water measurement may sometimes be used, but they are subject to limitations and are available only under special conditions. Some of them have not yet been checked sufficiently by accepted methods to permit their use alone.

(1) Traveling screen
(2) Volumetric or bulk
(3) Color method
(4) Brine velocity

MEASUREMENTS, HEAD

6 Head measurements consist of the determination of:

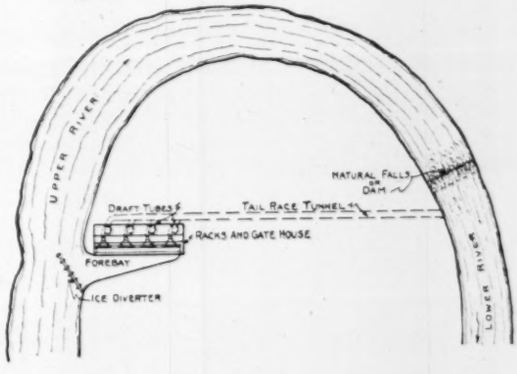
(*a*) Gross Head
(*b*) Net Head

6a *Gross head.* The determination of the gross head consists of measurements of difference of elevation between two water surfaces.

Preparations for measuring the gross head require

(1) Establishing bench marks from which the elevation of the water surfaces may be determined by differential leveling.

(2) Providing gage boards and setting them by differential leveling. From these the elevation of the water surfaces may be obtained by direct reading.



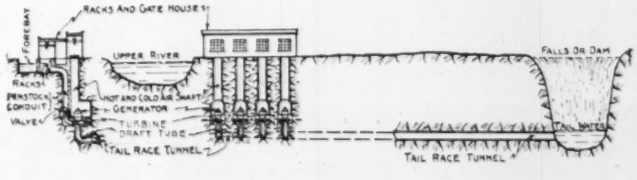


FIG. 3

(3) Providing stilling boxes and hook gages at points of desired measurements, and referring them to the bench marks.

6b *Net Head.* The determination of the *net head* consists of measurements establishing the difference in elevation of the points between which the net head is to be determined and measurement of areas of the conduits at these two points, by means of which the velocity head can be computed. The preparations required for determining the net head acting on a turbine are as follows:

(1) *Open-Flume Turbines.* Provide board, rod or float gages in the open turbine flume, and if practicable near the center of the setting, and similar gages in the tail race, all gages being located at points reasonably free from local disturbances. Gages are to be placed so as to be uninfluenced by velocity effects. If this is impracticable when the gages are set in the open channel, they should be placed in properly arranged stilling boxes. When stilling boxes are used, the communication between the box and channel should consist of one or more piezometer openings in a plane surface parallel to the flow, thereby avoiding velocity effects. When board gages are used at the side of the channel, they should be flush with the wall surface.

(2) *Encased Turbines.* Measure the area of the casing intake, provide piezometers at this point and connect them to separate gages. If spring gages are used, the elevation of the center of the dial is to be determined, and such gages are to be piped so that the air can be absolutely removed from the pipe leading to it. The piezometer orifices should be approximately $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter. Provide also a gage of either the board, rod or float type and locate it in the tail race at a point reasonably free from local disturbances, and otherwise following the directions given above for the open-flume turbines.

[1] See footnote, page 248.

Measurements, Speeds

7 There are two methods of speed determination.

7a *The Speed of Revolution* of a shaft is determined by means of a hand revolution counter and a watch, or a recording revolution counter. For accurate work and in all cases for low speeds a stop watch and revolution counter must be used.

7b *A Recording Speed Indicator* is used to obtain the average speed during a test run covering a considerable time interval in place of a series of readings at regular intervals or to determine the variation of speed for governor tests.

Measurements, Power

8 There are two methods available for measuring the power, viz., the *dynamometer method* and the *electric method*.

In addition to the power so measured, there may be other quantities of power to be included with the power supplied by the turbine shaft, such as the power for the governor pumps when driven by the turbine shaft.

8a *Dynamometer Method.* The dynamometer method is suitable where the turbine drives equipment which cannot be used to measure power or in the case of hydroelectric plants where the generator efficiency is unknown or known for only one speed where knowledge of the variable speed characteristics is desirable.

8b *The Electric Method* is applicable to hydroelectric plants, the power of the turbine being computed from the electric output. The power delivered to the generator shaft is determined by adding to the power output at the generator terminals all other power furnished by the shaft, such as generator losses that are absorbing power directly from the shaft, or power for operating exciters which are driven by the shaft; all of these items to be measured or calculated in accordance with the lastest A.I.E.E. Standardization Rules.

The power determined above is equal to the power delivered to the generator by the turbine shaft when connected direct to the generator shaft, but must be increased by the losses of any intermediate transmitting device, such as a gear or belt drive.

In cases where the turbine supplies the power for extra ventilation for the generator, it may or may not be necessary to treat the power for ventilation independently as part of the output of the turbine. Such amounts of power must be handled consistently with the specifications relating to the generator tests and generator efficiency.

Reduced or negative windage, if any, due to extra ventilation should be considered in determining the generator losses.

Instruments and Apparatus

9 The apparatus and instruments required for the various measurements noted are herewith summarized for convenience of reference. Directions for the use and calibration of these instruments and appliances are given in Par. 101 to 197 of the Code on "Instruments and Apparatus."

9a *Measuring Water*
- (1) Venturi meter
- (2) Salt solution
- (3) Pitot tube
- (4) Weir
- (5) Current meter
- (6) Special methods.

9b *Measuring Head*
- (1) Direct measurements
- (2) Float gage
- (3) Hook gage
- (4) Stilling box
- (5) Pressure gage
- (6) Board gage
- (7) Piezometer.

9c *Measuring Speed*
- (1) Hand revolution counter
- (2) Continuous revolution counter
- (3) Electric speed indicator.

9d *Measuring Power*
- (1) Dynamometer
- (2) Electric load

Operating Conditions

10 Determine what the test operating conditions should be to conform to the object in view and see that they prevail throughout the trial. As the head on a water-power plant is rarely constant throughout an extended period of time, the working head during the test may be different from the head for which the turbine was designed or under which guarantees were made. In such cases it is necessary, especially in acceptance tests, to correct by computation the results for this deviation of head.

11 Acceptance tests should be made, if possible, under the head and at the speed specified in the contract. The net head shall not differ from the specified head by more than 10 per cent unless the speed of the turbine shall be adjusted to correspond to the head under which the test is made. If the speed is changed in proportion to the square root of the head, the horsepower output will change in proportion to the three-halves power of the head, and the turbine efficiency may be assumed to remain the same for a range of head variation of 15 per cent.

12 Fluctuation of load during any single run of an acceptance test must not exceed 5 per cent above or below the prescribed load. The head under which a test run is made shall not vary more than 2 per cent from the head for which the proper speed has been fixed at the beginning of the run. If these limitations cannot be complied with by the use of the commercial load, an artificial load must be provided.

13 Apparatus installed for purposes of test must be arranged so as not to affect the performance of the turbine or other parts of the equipment under test. If this cannot be done, a special experiment must be made to determine the effect of removing and replacing the apparatus in question and a proper allowance made therefore.

14 The unit under acceptance test must be in normal operating condition throughout the test, and must have been operated under load for an aggregate time of at least three days prior to the test if so required by either party. A careful inspection should be made of the turbine before and after the test to determine that the water passages are free from obstructions and all parts in normal operating condition.

Duration

15 The duration of an efficiency test depends mainly upon the method of water measurement employed. Sufficient time must be allowed to obtain a requisite number of observations to insure a reliable average.

Records

16 A sufficient number of blank tables should be prepared for every observer, and the readings taken by the individual observers should be entered in a table or log of data and results immediately after making the test. All readings should be taken against time and also by signal where there is some special reason for signal readings. Instrument calibrations and correction curves should be prepared in advance of the test, and measures taken to enable results to be computed as quickly as possible during the course of the test or before the work of testing shall be considered to have been completed. If this rule is carried out, errors will generally be detected in time to correct the readings in question at once.

17 In order to avoid the possible necessity of throwing out an entire series of observations due to some one or more errors, it is advisable that the computations and the plotting of results be completed as soon after the observations are taken as possible. If this is done before leaving the test room and particularly before removing the test apparatus, the observations in question can be repeated without much difficulty.

Calculations of Results

18 The method of calculating the leading data and results are given below under the following headings:

- (*a*) Rate of flow
- (*b*) Head
- (*c*) Power
- (*d*) Efficiency.

18a *Rate of flow.* This is obtained either by the velocity-area method, which involves the determination of the mean velocity of the water, and with the cross-sectional area of the conduit known, the rate of flow equals the product of the two factors; or by the direct-discharge methods, which require the determination of the weight or volume of water flowing in a given time.

18b *Head.*

(1) Gross or Total Hydrostatic Head. This is obtained by taking the difference in elevation between the head water surface and tail water surface of a hydraulic power plant when the plant is not in operation.

(2)[1] Net or Effective Head. The effective head acting on a plant or division of a plant is the pressure head (if a closed conduit) or elevation of the water surface (if an open conduit) at the entrance section, plus the velocity head at this point, less the sum of the pressure head or elevation of the water surface and velocity head at the discharge section of the plant or division of the plant in question when the plant is in operation.

[1] See footnote, page 248.

In the case of an open-flume turbine the velocity of the water coming into the turbine flume is not considered as being effective and the effective head on the turbine in that case is the difference in elevation between head water in the flume near the center of the turbine and the tail race at the end of the draft tube sub-division, less the velocity head at the latter point.

In the case of an encased turbine the velocity of the water entering the casing is considered to be effective and the effective head on the turbine in that case is the pressure head plus velocity head at the casing intake plus the difference in elevation between the point of measurement and the end of the draft tube sub-division, less the velocity head at the latter point.

In the case of an impulse wheel or turbine without a draft tube the effective head on the wheel or turbine shall be considered to be the pressure head at the nozzle plus the velocity head at this point plus the elevation of this point above the tail water.

18c *Power*

(1) *Potential Energy.* The total potential energy of any hydraulic plant or any part thereof is that latent in the available rate of flow of water due to the difference of elevation (Par. 18b) between the upper and lower ends of the plant or part thereof.

The rate of work in horsepower (theoretical horsepower) is expressed as follows:

$$\text{T.hp.} = \frac{Q \times W \times H}{550}$$

where Q = cu. ft. per sec.
W = weight per cu. ft.
H = gross head as defined in Par. 18b.

(2) *Water Horsepower.* The available water horsepower is found by the following formula:

$$\text{W.hp.} = \frac{Q \times W \times \text{effective head}}{550}$$

where Q = cu. ft. per sec.
W = weight per cu. ft.

(3) *Brake Horsepower.* The brake horsepower is the power delivered by the turbine shaft. Power measuring methods are summarized in Par. 9d

In the case of direct-connected hydroelectric units, the delivery of power (b.hp.) from the turbine is considered to be at a point on the turbine shaft beyond which the turbine manufacturer furnishes no bearings, or beyond which he has connected no power-consuming devices.

As an illustration of this, take the case of a single vertical direct-connected three-guide-bearing unit with thrust bearing mounted on top of the generator. If the turbine manufacturer furnishes only the lower guide-bearing, the power is to be assumed as delivered between the turbine guide bearing and the lower generator bearing. If the turbine manufacturer furnishes two bearings beyond the runner, then the power is assumed to be delivered beyond the second bearing.

18d *Efficiency.* The efficiency of a hydraulic plant or any subdivision of the plant is the ratio of the energy made useful, to that which is available. For some parts of the plant the efficiency may be expressed directly in terms of ratio of heads, the losses which occur when there is no leakage being losses of head. For parts of the plant including the turbine it must be expressed as a ratio of powers. Where there is leakage, a correction must be made for the power corresponding to the loss thus sustained.

The various efficiencies are defined as follows:

(1) *Plant Efficiency.* The plant efficiency is the relation expressed as a ratio of "brake horsepower" developed by the turbine to "theoretical horsepower" of the water, or

$$\text{Plant Efficiency (expressed as a percentage)} = \frac{\text{B.hp.}}{\text{T.hp.}} \times 100.$$

(2) *Turbine Efficiency.* The turbine efficiency is found by the following formula:

$$\text{Turbine Efficiency (expressed as a percentage)} = \frac{\text{B.hp.}}{\text{W.hp.}} \times 100.$$

(3) *Part-Plant Efficiency.* The efficiency of any part of the plant not including the turbine, is the ratio of the W.hp. at the point of discharge to the W.hp. at the entrance. If there are no leakage losses between these two points, the efficiency may be expressed as a direct ratio between the effective heads at the two points.

The efficiency of any part of the plant including the turbine is the ratio of the b.hp. delivered by the turbine shaft to the available W.hp. entering that part of the plant for which the efficiency is desired.

DATA AND RESULTS

19 The data and results of the test are to be reported in accordance with the appended forms, the first of which, Table 1, gives the general data covering the leading features and dimensions of the entire plant; and the second, Table 2, a summary of the principal quantities and leading results.

TABLE 1 GENERAL DATA CONCERNING PLANT

HEAD-WATER EQUIPMENT

(a) *Reservoir*

(1)	Name	
(2)	Distance from power plant	mi.
(3)	Area at surface of full reservoir	acres
(4)	Area at each foot of depth	acres
(5)	Draft	ft.
(6)	Capacity	cu. ft.
(7)	Outlet area	sq. ft.

(b) *Pond*

(8)	Surface area of full pond	sq. ft.
(9)	Elevation of surface of full pond	ft.
(10)	Draft	ft.
(11)	Capacity	cu. ft.
(12)	Spillway length	ft.
(13)	Elevation of crest of spillway	ft.

(c) *Closed Conduits*

(14)	Area of intake	sq. ft.
(15)	Area of conduits	sq. ft.
(16)	Length	ft.

TAIL-WATER EQUIPMENT

(d) *Open Conduits*

(17)	Area of intake	sq. ft.
(18)	Area of conduit with full discharge	sq. ft.
	Area of conduit with part discharge	sq. ft.
(19)	Wetted perimeter	ft.
(20)	Length	ft.
(21)	Depth with full discharge	ft.
(22)	Slope	ft. per 100

(e) *Forebay*

(23)	Area with full pond	sq. ft.
(24)	Net rack area	sq. ft.
(25)	Net area of intakes	sq. ft.
(26)	Submergence of top of intake with full pond	ft.
(27)	Elevation of surface with full pond	ft.
(28)	Spillway length	ft.
(29)	Elevation of crest of spillway	ft.

(f) *Penstocks*

(30)	Inlet area	sq. ft.
(31)	Net area of penstock (average area if of variable diameter)	sq. ft.
(32)	Length	ft.
(33)	Area at turbine connection	sq. ft.

(g) *Standpipe*

(34)	Distance from turbine	ft.
(35)	Type (open, tank, differential, etc.)	
(36)	Net area at penstock connection	sq. ft.
(37)	Net area at tank	sq. ft.
(38)	Net area at throttle if any	sq. ft.
(39)	Elevation at connection to penstock	ft.
(40)	Elevation of top	ft.
(41)	Elevation of overflow	ft.
(42)	Overflow area with 1 ft. discharge depth	sq. ft.

TURBINE EQUIPMENT

(h) *Open-Flume Settings*

(43)	Net rack area per unit	sq. ft.
(44)	Intake area	sq. ft.
(45)	Dimensions of flume	
(46)	Submergence of turbine	ft.
(47)	Type of turbine	

(i) *Encased Settings*

(48)	Type of casing (cylindrical, spiral, etc.)	
(49)	Area of inlet	sq. ft.
(50)	Diameter of casing	ft.
(51)	Length of casing	ft.
(52)	Area of spiral at several points	sq. ft.
(53)	Type of turbine	

(j) *Turbine Runners*

(54)	Reaction or impulse	
(55)	Kind of buckets	
(56)	Material of runner or disk	
(57)	Inlet depth of buckets	in.
(58)	Total discharge area of buckets	sq. in.
(59)	Nominal diameter of runner	in.
(60)	Maximum discharge diameter	in.

(k) *Turbine*

(61)	Type (Whether horizontal or vertical, reaction or impulse, open-flume or encased, cylindrical or spiral casing, needle or deflecting nozzle, swivel or cylinder gate, single or multiple runner, outside or inside gate mechanism, etc.)	
(62)	Rated capacity under.....ft. head	b.hp.
(63)	R.p.m. at rated capacity	r.p.m.
(64)	Maximum gate opening	in.
(65)	Maximum net nozzle area	sq. in.

(l) *Draft Tube*

(66)	Area at runner discharge	sq. ft.
(67)	Area at outlet	sq. ft.
(68)	Maximum gross draft head	ft.
(69)	Minimum gross draft head (Distance from center of shaft or bottom of runner to lowest and highest tailwater, for horizontal or vertical turbines, respectively.)	ft
(70)	Length of draft tube (on center line)	ft.
(71)	Area of tube at several points	sq. ft.

Tail-Water Equipment

(*m*) *Tail Race*
- (72) Cross-sectional area at draft tube ..... sq.ft.
- (73) Depth ..... ft.
- (74) Wetted perimeter ..... ft.
- (75) Surface slope ..... ft. per 100

Load

(*n*) *Mechanical*
- (76) Kind (industrial, brake, dynamometer, etc.)
- (77) Capacity

(*o*) *Electrical*
- (78) Kind (industrial, water rheostat, etc.)
- (79) A.c., or d.c. generator
- (80) Capacity (A.I.E.E. rating) ....kw. or ....kva
- (81) Frequency ..... cycles
- (82) Phase
- (83) Voltage ..... volts
- (84) Efficiency of generator at various outputs and various power factors, if a.c. ..... per cent
- (85) Exciter capacity ..... kw.
- (86) Exciter voltage ..... volt.

Auxiliary Equipment

(*p*) *Governor*
- (87) Capacity ..... ft-lb.
- (88) Type (oil-pressure, water-pressure or mechanical)
- (89) Governing system (unit or central)
- (90) Pressure system (open or closed)
- (91) Working pressure ..... lb.
- (92) Closing time (full stroke) ..... sec.
- (93) Opening time (full stroke) ..... sec.
- (94) Difference in speed between no load and full load ..... per cent
- (95) Capacity of oil pump ..... gal. per min.
- (96) Volume of pressure tank ..... cu. ft.
- (97) Volume of receiving tank ..... cu. ft.
- (98) Diameter and length of pipe:
  - (*a*) Between pressure tank and regulating valve ..... in. ..... ft.
  - (*b*) Between regulating valve and cylinder ..... in. ..... ft.
  - (*c*) Between regulating valve and receiving tank ..... in. ..... ft.
  - (*d*) Between pump and pressure tank ..... in. ..... ft.
  - (*e*) Between pump and receiving tank ..... in. ..... ft.
- (99) Flywheel effect
  - (*a*) Of turbine rotating parts (Wr^2) ..... ft^2-lb.
  - (*b*) Generator rotating parts ..... ft^2-lb.
  - (*c*) Separate flywheel ..... ft^2-lb.
  - (*d*) Gears, pulleys, etc ..... ft^2-lb.
- (100) Synchronizing device
- (101) Load limiting device

(*q*) *Pressure Regulator*
- (102) Discharge capacity ..... cu. ft. per sec.
- (103) Type (governor-operated or automatic)

TABLE 2 PRINCIPAL DATA AND LEADING RESULTS

- (1) Date of test
- (2) Test of hydraulic plant located at
  - To determine
  - Test conducted by
- (3) Type of turbines and class of service
  - (*a*) Name of builder
- (4) Type of generators, if any
  - (*a*) Name of builder
- (5) Rated power of turbines ..... b.hp.
- (6) Rated flow of water, each ..... cu. ft. per sec.

General Data

- (7) Method employed for measuring water
- (8) Method employed for measuring power
- (9) Duration of period covering water measurement ..... hr.
- (10) Duration of period covering power measurement ..... hr.

		Plant test at full gate	Turbine test at gate
(11)	Volume of water flowing ... cu. ft. per sec.		
(12)	Leakage of water flowing .. cu. ft. per sec.		
(13)	Net volume of water utilized ..... cu. ft. per sec.		
	(*a*) Weight of water utilized per sec. . lb.		
(14)	Gross head, average ..... ft.		
(15)	Effective head, average ..... ft.		
(16)	Revolutions per min., average .... r.p.m.		
(17)	Theoretical horsepower of water ... t.hp.		
(18)	Water horsepower ..... w.hp.		
(19)	Brake horsepower developed by brake test ..... b.hp.		
(20)	Electrical output of generator ..... e.hp.		
(21)	Brake horsepower by calculation from generator test ..... b.hp.		

Efficiency

- (22) Plant efficiency ..... per cent
- (23) Turbine-setting efficiency ..... per cent
- (24) Efficiency as rated or guaranteed by builders ..... per cent

Research Results

- (25) Water flowing per sec.
  - (*a*) full capacity ..... cu. ft.
  - (*b*) 75 per cent capacity ..... cu. ft.
  - (*c*) 50 per cent capacity ..... cu. ft.
  - (*d*) 25 per cent capacity ..... cu. ft.
- (26) Head lost (gross head—effective head)
  - (*a*) Full capacity ..... ft.
  - (*b*) 75 per cent capacity ..... ft.
  - (*c*) 50 per cent capacity ..... ft.
  - (*d*) 25 per cent capacity ..... ft.
- (27) Brake horsepower developed
  - (*a*) Full capacity ..... b.hp.
  - (*b*) 75 per cent capacity ..... b.hp.
  - (*c*) 50 per cent capacity ..... b.hp.
  - (*d*) 25 per cent capacity ..... b.hp.
- (28) Efficiency at turbine coupling
  - (*a*) Full capacity ..... per cent
  - (*b*) 75 per cent capacity ..... per cent
  - (*c*) 50 per cent capacity ..... per cent
  - (*d*) 25 per cent capacity ..... per cent
- (29) Efficiency at switchboard of generator
  - (*a*) Full capacity ..... per cent
  - (*b*) 75 per cent capacity ..... per cent
  - (*c*) 50 per cent capacity ..... per cent
  - (*d*) 25 per cent capacity ..... per cent
- (30) Turbine results at various gate openings

	Water, (c.f.s.)	Brake hp.	Efficiency, per cent
(*a*) Full gate			
(*b*) 0.9 gate			
(*c*) 0.8 gate			
(*d*) 0.7 gate			
(*e*) 0.6 gate			
(*f*) 0.5 gate			

Sections of Code on Instruments and Apparatus Referring to This Test Code

Power Measuring Apparatus

101 There are two types of apparatus used to measure the power output of a hydraulic turbine, *viz.*, dynamometers and electric generators, that are direct connected to the turbine shaft. The latter apparatus is preferred to dynamometers on turbines that are used to drive electric generators.

Dynamometers

102 Dynamometers are of two general types; *viz.*, *absorption dynamometers* which absorb the power by mechanical or fluid friction and dissipate it as heat, and *transmission* dynamometers, which transmit or pass along the power they measure, wasting only a small part in friction.

103 The absorption dynamometers are represented by the following:

Prony brake, which is limited to small amounts of power.

Alden dynamometer, which is an improved form of Prony brake and is of much greater capacity.

Froude or *Water Brake*, which is suitable for higher speeds than the other two.

Electric Generators

104 Whenever an electric generator is used for measuring the power output of the turbine the electrical output of the generator divided by its efficiency represents this power. The generator output is measured during the test of the turbine. The efficiency should be obtained from the manufacturer of the generator or by a separate test.

105 It is preferred that the generator efficiency be determined by the manufacturer before leaving the factory under the load, voltage and speed conditions duplicating those obtained during the test of the turbine, if the manufacturer's data are dependable. Otherwise, the generator efficiency should be determined for the loads, voltages and speeds to be obtained when testing the turbine, by the separate-loss method, the electrical measurements being made in accordance with The Standards of the American Institute of Electrical Engineers, 1921 Revision, Sections 4334–4342. In determining the generator efficiency by the separate-loss method it is calculated by dividing the generator output by the sum of the output and the various generator losses.

106 When practicable the generator, if of the alternating current type, is to be separately excited during both generator and turbine power tests, and the excitation loss is not to be included in computing generator efficiency, and is therefore, also to be omitted in computing power output at the turbine coupling. If the main generator is excited from a direct connected exciter or from an exciter belted from the shaft of the unit, the power of which is to be measured, then to the output of the main generator, computed without reference to excitation, there is to be added the output of the exciter divided by its efficiency; and in the case of the belted exciter, the belt losses

are to be added. It is preferable, for simplicity, that when possible the current for excitation shall be obtained from a separately driven exciter.

107 The losses in a constant-potential synchronous generator are of two classes; namely, those which remain substantially constant at all loads and those which vary with the load. The former include core losses, windage and friction. The latter include I^2R losses in the armature winding. The simple method of determining the losses and hence the efficiency is only approximate, since the losses which are assumed to be constant do actually vary to some extent with the load, and also because the actual I^2R loss in the armature windings is sometimes appreciably greater than the calculated I^2R loss. The difference between the approximate losses and the actual losses is termed "stray load losses." These latter are due to distortion in electric or magnetic fluxes from their no-load distributions or values brought about by the load current. They are usually only approximately measurable, but are of sufficient magnitude to require consideration when determining generator efficiency by the separate-loss method.

108 When determined by the separate-loss method, the generator efficiency, in the case of polyphase alternators separately excited, is to be taken as

E = [(kw. output at terminals)] divided by [(kw. output) plus (friction and windage) plus (I^2R loss in armature) plus (stray load losses)] all losses being expressed in kilowatts.

KW. OUTPUT

109 The kw. output of the generator should be measured by a polyphase wattmeter and the necessary instrument transformers at the generator terminals.

FRICTION AND WINDAGE

110 The value of generator windage and friction should be directly measured by driving the generator alone by an independent motor, the output of which shall be determined by multiplying the motor input by its efficiency.[2] The generator shall not be connected to a load or have its field excited. The output of the driving motor will represent the generator loss due to bearing friction, collector ring friction and windage. With units having direct-connected exciters, the windage and friction may be measured by driving the generator by the exciter run as a motor. When the windage and friction cannot be directly measured, it is to be taken either from shop tests of generators of similar design, or from a retardation test made after installation. When possible, more than one method should be used in order to obtain a check. In making a retardation test, the turbine shaft and runner, or the turbine runner, are to be disconnected when practicable from the generator shaft, to enable the windage and friction of the generator alone to be measured. When the turbine shaft or runner cannot be disconnected, the generator windage and friction are to be computed by deducting from the total windage and friction that of the turbine, which for this purpose may be found with sufficient accuracy from the formula:

$$W = KBD^4N^3$$

where W = turbine windage and friction in kilowatts.
K = an empirical coefficient which may be taken as 0.000115, as determined from available test data.
B = height of turbine distributor in feet.
D = entrance diameter of runner in feet at center line of distributor.
N = revolutions per second.

I^2R LOSS IN ARMATURE

111 The I^2R loss in the armature can be calculated for each load from the armature current and electrical resistance of the armature. This requires the measurement of the resistance by a Wheatstone bridge at various loads. These measurements can be made immediately after the stray load tests (see paragraph 112) for each load, before the resistance has had time to change because of cooling of the generator.

STRAY LOAD LOSSES

112 The stray load losses which include iron losses and eddy-current losses in the copper, due to fluxes varying with load and also to saturation, shall be determined by driving the generator on short circuit and at the current corresponding with the generator load under consideration. An independent motor, or the exciter if direct connected, should be used to drive the generator, it being necessary to determine the efficiency of the motor as prescribed in the section on Friction and Windage, paragraph 110. The output of the motor driving the generator alone when reduced by the sum of the windage and friction and I^2R losses of the generator equals the stray load loss for the generator at the load corresponding with the generator current.

113 If, under special conditions of an installation, other losses exist, these are to be added to the stray load losses determined above.

SALT SOLUTION METHOD

114 This method consists of introducing salt at a known rate into a body of flowing water, determining the quantity of salt in the water at a point far enough downstream to insure a thorough mixture with the water to be measured, and calculating from these data the quantity of water flowing between these points per unit of time.

115 The practical details require careful consideration, but when the necessary conditions are properly fulfilled this method of measuring flowing water, especially large quantities, is practical and accurate.

116 Two important requirements are (1) that the salt must be added at a fairly constant rate, and (2) that thorough mixture takes place before the samples are drawn off for analysis.

117 The salt solution method of measuring the flow of water may be conveniently divided into that part of the work which is principally mechanical and that which is principally chemical. The mechanical division embraces the work necessary to prepare the equipment for the introduction of the salt and for taking samples, the preparation of the salt solution to be introduced into the water, its actual introduction into the stream, and the taking of the samples. The chemical division embraces the preparation of the special dilution and the titration of the samples.

118 Common salt, NaCl (a quality known to the trade as "coarse-fine"), is usually employed. The salt is dissolved in water to form a brine before being introduced into the water to be measured.

119 It is desirable to have the initial brine supply highly concentrated but not quite saturated. A solution consisting of 16 lb. of salt per cu. ft. of water is satisfactory. (Specific gravity of about 1.18.)

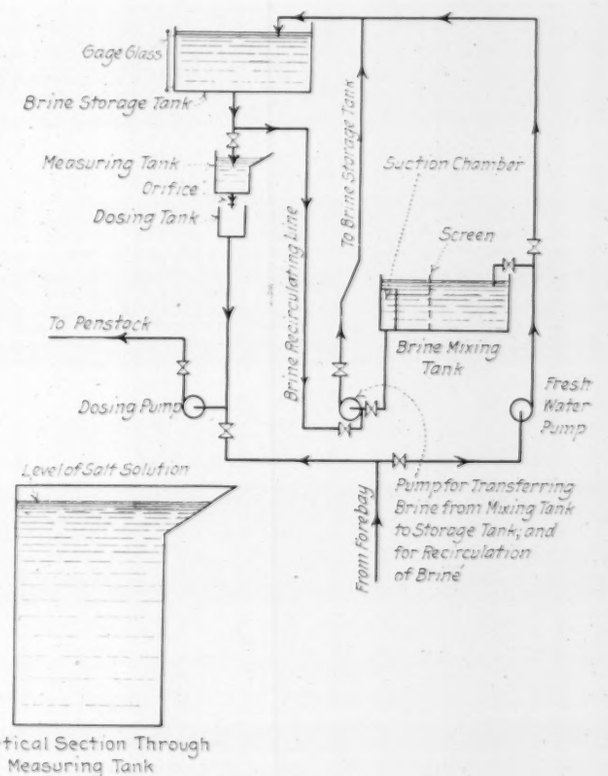


FIG. 101

The apparatus required is as follows:

1 A brine-mixing tank
1-a A brine storage tank
2 A measuring tank with orifice or nozzle
2-a A dosing tank
3 Equipment for introducing the salt solution into the flowing water
4 Equipment for taking samples

120 The brine-mixing tank should be divided into two compartments with screens between them, so that foreign matter which may enter the brine with the salt can be screened out before it enters the storage tank. All tanks should be located so that there will be no danger of the salt or the brine being carried into the water to be measured other than through the measuring tank. A pump will usually be required to supply the water to the mixing tank. The brine storage tank should be elevated above the mixing and measuring tanks.

121 A pump, in many cases the same pump referred to above, will be required in order to pump the brine from the mixing tank to the storage tank. An arrangement of piping is necessary to permit a circulation of the salt solution between the two tanks to insure a brine of equal strength. It is advisable to have the storage tank of sufficient size to hold brine for a number of measurements. A satisfactory arrangement is shown in Fig. 101.

122 One way of getting a fairly constant rate of discharge is to use a measuring tank having an orifice or discharge nozzle. With this the level of the solution in the tank is kept constant throughout a measurement to

[2] This necessitates getting from the motor manufacturer data showing the efficiency of the motor at the speeds and loads actually obtained or determining the efficiency by means of a Prony brake test of the motor. During such a brake test the power output and the speed of the motor should be varied while the following data are taken:

If D. C. Motor	*If A. C. Motor*
Brake Horsepower	Brake Horsepower
R.P.M.	R.P.M.
Terminal Voltage	Terminal Voltage
Field Current	Electrical input by wattmeter
Armature Current	

Performance curves should be drawn that will permit of determining the efficiency of the motor when used under any combination of the variables just mentioned.

insure a constant rate of discharge. A projection, having an inclined bottom, on the upper part of one side of the tank, as shown in Fig. 101, accentuates any variation in the level of the solution in the tank.

123 One of the following two means of introducing the solution from the discharge orifice or nozzle into the stream of water to be measured may be necessary.

124 (1) Where the distance between the point of introducing the salt solution and the point where the samples are to be taken is great and if the water is more or less turbulent, the solution may be introduced without much effort to attain uniform distribution, especially if the flow is concentrated in a closed pressure conduit.

125 (2) Where the distance is short, every effort must be made to introduce the solution uniformly over the whole area of the canal or conduit in which the water flows, and some regard must be taken of the unequal velocities in the stream. Sometimes the solution is introduced through a series of pipes having numerous small orifices, the pipes and orifices being distributed to suit the flow. To insure sufficient discharge and also to insure a thorough mixture, a pump should be installed between the dosing tank and the point of introduction into the conduit. The pump suction in addition to drawing brine from the dosing tank obtains its main supply from the conduit or canal in which the water to be measured flows and from a point upstream from the point of introduction. The pump suction head must be reasonably uniform and the level of the dosing tank must be maintained by means of a throttle valve. The horizontal cross-section of the dosing tank should be small, in order to exaggerate changes of level resulting from fluctuations in the rate at which brine is supplied.

126 The introduction of the salt solution into the distributing system under high pressure is favorable to a uniform mixture and the solution shall be introduced under sufficient pressure to produce a uniform mixture as shown by the samples taken after mixing. Wherever possible, the brine should be added to the water on the inlet side of the turbine and the final sample of water should be taken on the discharge side of the turbine to insure thorough mixing of the brine and the water.

127 While the salt solution is being introduced, samples should be taken continuously as follows:

(*a*) Sample of salt solution
(*b*) Sample of natural stream water
(*c*) Sample of dosed stream water after the salt solution has become thoroughly mixed with the water in the stream.

128 A sample of the salt solution should be taken continuously from a point as near the dosing pump as possible.

129 The sample of natural stream water should be taken continuously well above the point where the salt solution is introduced and during the period when it is being introduced.

130 The dosed stream sample should be taken far enough downstream and after sufficient lapse of time to insure a thorough mixture and stable conditions. The samples should be continuous over a period of not less than 5 minutes and should be secured by pumping or by means of bottles arranged to fill slowly.

131 Where the sampling station covers a large cross-section samples must be taken from points distributed well over the entire area, until it is found by trial that the distribution is so uniform that samples from a few points are sufficient. Samples should be taken from not less than 6 points and preferably more.

132 It is necessary to make a preliminary investigation to determine the proper place for taking samples of dosed stream water, and the necessary time interval between the time of beginning dosing and taking the samples.

133 The salt solution should be added to the stream of water to be measured at such a rate as to increase its salt content by at least 0.003 lb. per cu. ft. and under no circumstances should the initial salt content exceed 25 per cent of the salt content of the dosed water.

134 The waters of natural streams usually contain an initial quantity of salt in solution, which must be considered in making a correct gaging.

135 The relative salt content of the various samples should be determined by titration against a standard silver nitrate solution by an experienced chemist.

136 *Calculation of Results.* The number of cubic feet per second of water dosed with a salt solution is equal to the ratio of (the weight of the salt introduced per second) to (the weight of a cubic foot of the water multiplied by the weight of salt added per pound of water in a sample of the dosed water).

Let Q = discharge in cu. ft. per second of stream to be measured.
q = cu. ft. per sec. of salt solution introduced.
C = concentration of salt solution in pounds per cu. ft.
C_1 = concentration of salt in the natural stream water in pounds per cu. ft.
C_2 = concentration of salt in the dosed stream water samples in pounds per cu. ft.

Then the following equation may be derived:

$$(Q + q)\ (C_2 - C_1) = q(C - C_1)$$

$$Q = \frac{(C - C_1)q}{C_2 - C_1} - q$$

137 Since concentrations are proportional to the volume of standard silver nitrate solution required to titrate unit volume, we have:

$$Q = \frac{(V - V_1)q}{V_2 - V_1} - q$$

in which,

V = volume of silver nitrate solution necessary to titrate unit volume of concentrated salt solution
V_1 = volume of silver nitrate solution necessary to titrate unit volume of normal stream water
V_2 = volume of silver nitrate solution necessary to titrate unit volume of dosed stream water.

If V is large compared to V_1 and $\frac{(V - V_1)q}{V_2 - V_1}$ is large compared to q, the equation reduces to

$$Q = \frac{qV}{V_2 - V_1}$$

138 A detailed discussion of the sources of error in the measurement of water by chemical gaging and the derivation of the formula given above, together with correction factors to be applied for more precise application of the method, is given in a paper by B. F. Groat in Trans. American Society of Civil Engineers, Vol. 80.

PITOT TUBE

139 The measurement of flow of water by means of pitot tubes cannot be regarded as an extremely accurate method on account of the difficulty

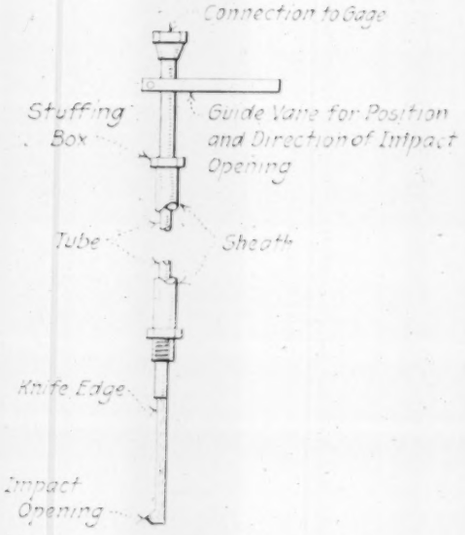


FIG. 102 SINGLE OPENING PITOT TUBE

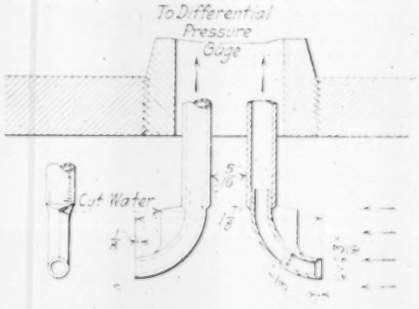


FIG. 103 THE PITOMETER

of duplicating the conditions under which the tube is calibrated with the conditions under which it is used. A tube properly calibrated in straight-line flow or in still water will give accurate determinations when used at the same velocities in a pipe in which the flow is free from whirls or eddies, but strictly speaking such conditions are never attained even in long straight pipes. Furthermore, the degree of disturbance cannot be observed or determined. The best that can be done is to calibrate the tube for straight-line flow and to use it only under conditions where reasonably straight and smooth flow may be expected to occur. The resulting error, although undeterminable, will then be small. (The magnitude of the error will be given in a later issue.)

140 The pitot tube is suitable for use only where the conditions of flow, as indicated by the readings, are reasonably steady. Steady readings are indicative of steady flow. The question of symmetrical distribution of flow in the pipe is not as important as steady flow. Well designed bends of long radius in the pipe will affect the distribution of velocity across the diameter of the pipe for a considerable distance beyond the bend, but this is not necessarily objectionable. It is desirable to have a run of straight pipe, at least 15 pipe diameters long, following short bends, valves and poorly designed intakes, and immediately preceding the pitot tube to minimize the disturbances to flow which may result from such features. The greater the length of the straight pipe ahead of the pitot tube the greater is the probability that parallel stream flow will exist, which will increase the accuracy of the velocity measurement. The uniformity of the readings obtained at the various points on repeated trials is the most reliable criterion by which to judge the character of the indications.

141 The single-opening pitot tube, Fig. 102, in connection with a "wall piezometer," i.e., not less than two pairs of diametrically opposed holes, that transmit only the pressure head of the water, affords the combination of the simplest and most easily constructed instrument. The piezometer holes shall not exceed $^1/_4$ in. diameter, their edges at the inside wall of the conduit shall be sharp, and the holes shall be normal to the internal surface of the wall.

142 The "Pitometer," Fig. 103, is a commercial adaptation of the Pitot principle. This instrument, as also all other tubes which are symmetrical, has the advantage of being reversible.

143 Different forms of pitot tubes may be used, provided they are properly calibrated. If calibration is impossible the form of the tube shown in Fig. 102 is to be used. The formula for use with this tube is $v = c \times \sqrt{2gh}$ where $c = 0.98$ and h is the difference in head between the readings of the pressure gage connected to the pitot tube and the one connected to the piezometer, expressed in feet of water. The coefficient for the Pitometer is furnished by the maker.

144 For measurement of water flowing in conduits under pressure, using pitot tubes, at least two tubes should be arranged to traverse two relatively perpendicular diameters. In the case of very large conduits, or those having unsymmetrical shape or flow, pitot tubes should be arranged to traverse

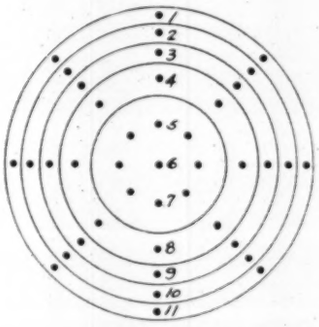


FIG. 104

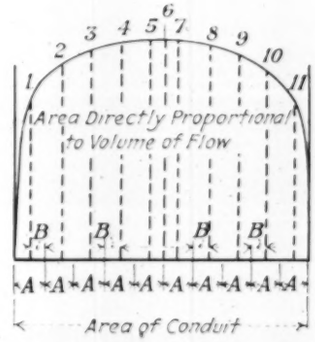

6
3 4 5 7 8 9 10
2
1
11
Area Directly Proportional to Volume of Flow
B B B B
A A A A A A A A A A
Area of Conduit
A = Equals Subdivisions of Area
B = 1/2 A

FIG. 105

the intermediate diameters completely or partially, giving traverses at 45 degree intervals. The piezometers for the various diameters should be connected so that they may be separately read. The conditions of measurement, including velocity distribution, length of straight run of penstock, and condition of piezometer orifices, should be such that no piezometer shall vary in its readings from the average of all the piezometers by more than 10 per cent of the average velocity head. The piezometer orifices should be flush with the inside surface of the penstock wall, and the wall should be smooth and parallel with the center line of the penstock in the vicinity of the orifices. The orifices should be $^1/_8$ inch to $^1/_4$ inch in diameter. The piezometer openings should be spaced around the wall of the conduit at equal angles at a section approximately one foot upstream from the pitot tube section to avoid the effect of the pitot tube supporting structure, the conduit being of uniform cross-section between the piezometer and the points of the pitot tubes.

145 The differential pressures obtained with the pitot tube should be measured as prescribed in paragraphs 191 to 194 of the section on Head-Measuring and Pressure-Measuring Apparatus.

146 Long tubes must be supported to prevent vibration, the support being designed so as to affect the readings as little as possible. In measuring the flow in open channels with pitot tubes, the observations and computations are similar to those used for current-meter measurements, which are described in a separate section.

147 For determining the flow in closed conduits under pressure the area of the conduit is divided into a number of equal concentric areas, the number depending upon the size of the conduit and the degree of accuracy required for the measurement. See Fig. 104. The tube stations are figured to come on the half area point of all the areas, with an extra station in the center of the pipe.

148 A diagram (see Fig. 105) is then constructed having an abscissa representing the conduit area, with vertical lines on the centers of the equal areas. By plotting velocities as ordinates on this diagram, and drawing a curve through the plotted points, the circumscribed area is proportional to the cubic-foot-seconds flowing through the conduit.

VENTURI METER

149 Figure 106 shows a Venturi tube in a horizontal position, with approximate dimensions as generally constructed, although it may be set at any desired angle. For testing hydraulic turbines the velocity through the throat is not to be more than 50 feet per second.

150 Two piezometer tubes are shown in Fig. 106, one at the throat and one at the upstream end of the meter tube. The difference between the indication at the upstream end of the meter tube and that at the throat is used in determining the discharge through the meter tube. The throat velocity with low rates of flow should be great enough so that the difference of pressure heads shown by the piezometers will cause a measurable indication, but should not be so great as to cause the throat pressure to drop below atmospheric, lest there be trouble with air leaking into the tubes.

151 The differential pressures between the inlet and the throat of the Venturi tube should be measured as prescribed in paragraphs 191 to 194 of the section on Head-Measuring and Pressure-Measuring Apparatus.

152 The upstream cone should have a summit angle, which is the angle between wall of the cone and the pipe wall extended, of about 21 degrees. The downstream cone should have a summit angle of not more than 5 degrees. All corners of the main water channels should be rounded. The pressure connections should be made to four or more standard piezometer holes equally spaced around the pipe and staggered with respect to the vertical. Except where standard throats with ring pressure chambers are

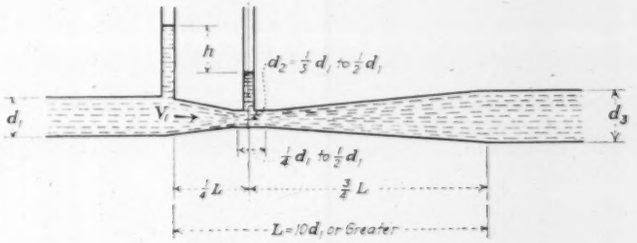


FIG. 6 VENTURI METER

used the pressure connections are to be connected to read individually or collectively, the object being to obtain the average pressure and avoid dependence on a single piezometer hole, subject to possible local disturbances. The meter tubes are generally made of cast iron but may be made of other materials such as plate steel, concrete or timber. The throat should be of metal accurately bored to size and smoothly finished. It is sometimes desirable to build a Venturi meter of wood, plate steel, or concrete into an existing conduit or in a tail race.

153 The value of C, the "coefficient" of the meter tube, built as above described, is to be taken as 0.99.

154 The formula for calculating the Venturi meter tube discharge is:

$$Q = C \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \sqrt{2gh}$$

where Q = cu. ft. per sec.
$C = 0.99$, the coefficient of the meter tube.
a_1 = area of the upstream end of the meter tube in sq. ft.
a_2 = area of the throat in sq. ft.
h = differential pressure between upstream and throat piezometers, expressed in feet of water.

155 More accurate results are obtained with Venturi tubes installed so that there are runs of straight pipe on the upstream and downstream sides of at least 8 and 3 pipe diameters, respectively, instead of being installed inside of an existing conduit, which may be of non-circular cross section or of varying cross section.

WEIR

156 The weir is a suitable means of measuring the flow of water in open channels when the obstruction of the channel and change of water levels, due to the interposition of the weir, are not objectionable. Many experiments have been made with weirs of different forms, resulting in a number of different formulas for weir discharge. All of these formulas are empirical and require the use of coefficients derived experimentally; consequently the accuracy of the results depends upon the accuracy of the experiments and the use of the formulas and coefficients under conditions identical with those under which the original experiments were made. Weirs carefully used under favorable circumstances are accurate within 1 per cent. Indiscriminate use of weir formulas and coefficients under unsuitable conditions has resulted in much confusion in regard to the accuracy of this method of water measurement.

157 The sharp crested rectangular weir without end contractions, known as the *suppressed weir*, in which the sides of the channel form the ends of the weir, is the basis of the formula and coefficients herein specified.

158 The formula to be used is:

$$Q = C\ L\ h^{3/2}$$

where Q = quantity in cu. ft. per sec.
L = length of weir in ft.
h = difference in level of surface of water upstream (a distance prescribed farther on in this section) and the crest of the weir in feet.

159 The following table gives the values of C for various heads (h) above the crest and heights of crest (P) above the bottom of the channel of approach. See Fig. 107.

160 VALUES OF C FOR VARIOUS HEADS AND HEIGHTS OF CREST P.
P = HEIGHT OF CREST ABOVE BOTTOM OF CHANNEL OF APPROACH

HEAD, h	HEIGHT OF CREST P. (ABOVE BOTTOM OF CHANNEL OF APPROACH), (FT.)										
(ft.)	4	5	6	7	8	9	10	12	14	16	20
1.0	3.376	3.356	3.344	3.335	3.329	3.325	3.322	3.317	3.314	3.311	3.308
1.2	3.391	3.366	3.350	3.339	3.332	3.326	3.322	3.316	3.311	3.308	3.305
1.4	3.409	3.378	3.359	3.346	3.336	3.330	3.324	3.316	3.311	3.307	3.303
1.6	3.429	3.392	3.370	3.354	3.343	3.334	3.328	3.319	3.312	3.308	3.302
1.8	3.450	3.408	3.382	3.363	3.350	3.340	3.333	3.322	3.315	3.309	3.303
2.0	...	3.425	3.394	3.373	3.358	3.347	3.338	3.325	3.317	3.311	3.304

161 (To facilitate computations, all corrections for velocity of approach have been included within the coefficients as given. These are therefore to be used in the formula stated above, the observed head being used without modification.)

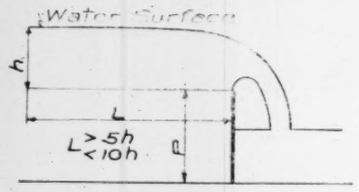


FIG. 107

162 The weir shall, if possible, be located on the tailrace side of the turbine, if used for turbine testing, and care shall be taken that smooth flow, free from eddies, surface disturbances or the presence of considerable quantities of air in suspension, exists in the channel of approach. To insure this condition the weir shall not be located too close to the end of the draft tube, and stilling racks (see Head-Measuring Apparatus) shall be used when required.

163 The channel of approach shall be straight, and of uniform cross-section. Where used, stilling racks shall be arranged to give approximately uniform velocity across the channel of approach. The uniformity of velocity shall be verified by current meter or otherwise.

164 One method of determining the head on the weir or the elevation of the surface of the flowing water, is by direct observation upon it as it flows. The head on the weir may also be observed by hook gages placed in stilling boxes communicating with orifices approximately 1 inch in diameter in the sides of the channel of approach, approximately 1 foot below the level of the crest, the head being observed independently at both sides of the channel. The head (h) on the weir shall be measured at a distance of not less than five nor more than ten times the thickness of the stream going over the weir upstream from the weir. The weir shall be sharp-crested, with smooth vertical crest wall, complete crest contraction, and free overfall. A metal crest free from rust, with sharp right angled corner on the upstream edge, a crest width of $^1/_8$ inch and beveled to an angle of 45 degrees on the downstream face, shall be used. The crest shall be carefully leveled.

165 Complete aeration of the nappe shall be secured and observations of the crest conditions and form of nappe shall be made during the test, to avoid defective conditions such as adhering nappe, disturbed or turbulent flow, or surging. Aeration of the nappe usually requires the construction of air passages leading to the space beneath the nappe. The sidewalls of the channel should be smooth and parallel and should extend downstream beyond the overfall above the level of the crest. Weirs of a length exceeding approximately twenty times the head (excepting in cases where the velocity of approach is extremely low); or weirs of moderate crest length having high velocities of approach; or those in which the velocity of approach is irregularly distributed, or in which the leading channel is subject to the action of the wind, shall either be subdivided into a number of sections or the head shall be observed not only at both sides but also at intermediate points across the channel of approach.

166 The head on a weir must be carefully measured. A small percentage error in head measurement causes approximately $1^1/_2$ times that error in calculated discharge. Considerable errors in the measured head may be made by careless methods of referring the crest level to the head gage scale, and by assuming that a non-level crest is level without knowing the average level. The mean level of the water surface must be measured, not the crests of the small waves or surges existing in all flowing water.

CURRENT METER

167 Ordinarily, the current meter is provided with a mechanism which completes an electric circuit at each revolution, or at a given number of revolutions of the current meter wheel. By means of wires connecting the meter to batteries and buzzer or other indicating device, the observer is enabled to determine the rate at which the wheel revolves. Some current meters are arranged with mechanical recording devices. Current meters may be suspended from a cable or attached to a rod. In the former case they are generally provided with electrical recording devices and these are better suited for large streams where observations are taken from a boat or cable station or other more or less insecure positions. Meters attached to rods are better suited for work in small streams or canals where observations are taken from a bridge.

168 The measurement of flow of water by means of a current meter cannot be regarded as an extremely accurate method on account of the difficulty of duplicating the conditions under which the instrument is calibrated with the conditions under which it is used. A meter properly calibrated in straight line flow or in still water will give accurate determinations when used at the same velocities in a stream in which the flow is free from whirls or eddies, but strictly speaking such conditions are never attained in streams. Furthermore, the degree of disturbance cannot be observed or determined. The best that can be done is to calibrate the meter for straight line flow and to use it only under conditions where reasonably straight and smooth flow may be expected to occur.

169 The meter should be calibrated before using on a test and also after using. If the current meter is to be used suspended from a cable or attached to a rod, it must be calibrated similarly.

170 The hydraulic section on which the measurements are to be taken is selected primarily with regard to flowage conditions. The bottom and sides should be smooth and the section uniform for a sufficient distance both up and down stream to insure a smooth flow and avoid turbulence. Accurate soundings should be taken at close enough intervals to insure an accurate determination of cross-sections. When soundings are made in a current, corrections should be made for the deflection of the sounding cable. Where meters suspended from flexible cables are to be used, it is desirable to take the soundings with cables giving the same deflections as the meter cables, insuring the determination of the cross-section in the same plane as the meter

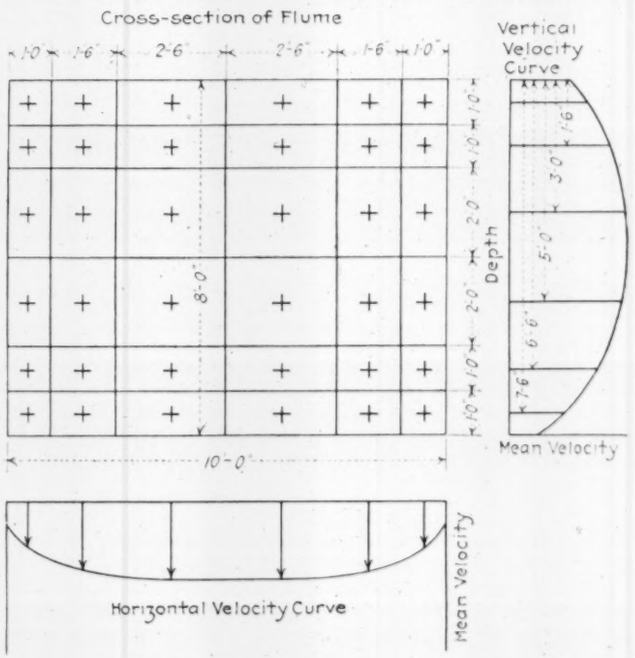


FIG. 108

readings. All soundings should be plotted for the same mean stage. The hydraulic section should then be laid out to some convenient scale and divided into sections or panels.

INDIVIDUAL UNIT TESTS

171 After the cross-section is accurately determined, it should be laid off in vertical sections and enough point stations located on the center line of each section to enable a consistent vertical curve to be plotted. The point method should be used, holding the meter at each predetermined point a sufficient time to allow the varying velocities of a cycle at that point to register. Under uniform velocity conditions the duration of time at each point should be not less than one minute. The top station should be just under the water surface and the lower station as near the bottom as the meter will operate. The depth of water should be accurately recorded during the test. After the vertical velocities are plotted and the areas planimetered in order to get the mean velocity, a horizontal velocity curve should be plotted from the mean vertical values.

172 By continuing the curves to the sides and bottom of the section, the entire area is considered in the determination of the quantity. See Fig. 108.

COMPLETE PLANT TESTS

173 When a section is large enough, or the possible distribution of the load is likely to affect the distribution of the flow, the section should be divided into two or more main panels, and these again divided into subpanels. An index point is then selected for each panel, preferably at the point of maximum velocity, which occurs usually at about 0.4 depth. In order to avoid the necessity of making a complete traverse of the section for each loading, the observations are made comparable by using two or

three meters. It is preferable to use three meters, one at the index point of each panel, while the second one is being used to make a traverse of the panel, the third meter being used as a master index meter fixed at one point in the stream. If only two meters are available, one should be fixed at the index point of one of the panels while the other is used to make the traverses of the various panels. All meter readings are to be reduced to percentages of the simultaneous index reading. Simultaneous observations should be taken of the time, time intervals, meter depths, (proportionate depths if water level varies), meter readings, and section gage readings, and notes taken from time to time regarding all matters pertaining to the work. Vertical velocity curves are plotted, these being located on vertical center lines of the sub-panels. The points of determination should be the sub-surface and bottom and enough intermediate points at even proportions of the depth to insure a proper determination of the vertical velocity curve. The sub-surface depth in each case should be just sufficient to insure a proper submerging of the meter; the bottom depth in each case being just enough above the bottom to allow the meter to clear properly. One of the points selected should be at 0.4 of the depth to correspond to the index reading. The meters in each panel should be interchanged from time to time and inspected frequently. All velocity observations of the vertical curves are first reduced by dividing each by the simultaneously determined velocity at the index in the same panel, and expressing the quotient as a percentage. The average of the accepted percentages of each point is computed, and divided by the average for the 0.4 depth point of the same vertical. A plot for each curve is constructed with percentage depths as ordinates and percentage velocities as abscissas. A smooth curve is drawn through the points. The coefficient of the curve is derived by measuring the area, this area being divided by the proportionate depth gives the mean abscissa of the curve, and the mean abscissa divided by 100 (the percentage at 0.4 depth point), gives the vertical velocity coefficient. A transverse curve is then plotted, using the 0.4 depth points on the verticals as points on the transverse curve. As in the case of the vertical curves, the first step in the transverse curve reductions is to divide the observed velocity at each point by simultaneously observed velocity at the index in the same panel. The percentages are then tabulated, arithmetic means are taken of all the observations at each point, and a curve drawn through all of the resulting points. In each sub-panel the mean percentage ordinate of the transverse curve is determined, the results giving the transverse coefficient in terms of 100 per cent at the index. The sub-panel areas at the mean water elevation are determined and expressed as percentages of the entire area. The transverse and vertical coefficients in each sub-panel are weighted according to the relation which the area of the sub-panel bears to the whole panel area. Accordingly, the general coefficient for the index is obtained by multiplying for each sub-panel the transverse coefficient by the vertical coefficient and by the percentage area, adding the results and dividing by 100.

174 The elevation of the water surface should be continuously observed during a run of current-meter measurements, preferably by direct measurements down to the surface from fixed points on a bridge or by means of stilling boxes. If the supporting rods for the meters are in the same cross-sectional plane as the meters, the area of the rods should be deducted from the wetted area of the channel in calculating the quantity. The meter should preferably be supported by rods placed a sufficient distance behind them to avoid any obstructive effect. When a heavy mast or supporting frame is used, it should be designed to offer a minimum disturbance, and should be located several feet downstream from the meter.

175 Velocities below 0.5 ft. per second cannot be accurately measured. A Venturi meter flume of plank can sometimes be built into a channel to increase the velocity, the throat making an ideal current meter station.

SPECIAL METHODS FOR MEASURING WATER

176 *Traveling Screen.* The traveling screen, also called the "diaphragm method" of measuring water, provides for the determination of the mean velocity from a single observation. This method requires elaborate preparations, but when the apparatus is once installed it may be used for as many observations as desired. It is adapted only to open channels of very regular cross-section. A very light canvas screen, varnished to insure imperviousness, is suspended by a stiff frame from a wheeled carriage mounted on tracks along the edges of the channels. The rate of movement of the screen must necessarily be the mean velocity of the water. A small crack about 0.5 inch should be provided between the screen and the sides and bottom of the channel to insure freedom of movement. Provision must be made for accurately observing the velocity of the screen, preferably by electric contacts and chronograph. The length of run of the screen should be sufficiently in excess of the portion used for measurement to provide ample space for starting and stopping the screen, so as to insure uniform conditions over the measured portion of the run. In determining the discharge, the velocity of the screen is to be multiplied by the average area of stream cross-section of the portion of the channel traversed. The variation of the level in the flume should be observed during the course of the run and the average elevation used in determining the area. It is possible to measure the flow of water within 1 per cent by this method under the most favorable circumstances.

177 *Volumetric or Bulk Method.* Volumetric methods of measuring water, which require the determination of the volume of water flowing in a given time by means of measuring vessels are limited to laboratory use and are outside of the scope of this code.

178 The bulk method is applicable only when there is available a reservoir of regular form, the volume of which, up to various water levels, may be accurately measured. In the case of a test on a turbine, the power must be measured continuously and the average obtained. It must be possible to shut off completely all inflow to the reservoir. The tightness of the gates and reservoir walls must be tested by closing all gates and observing over a time of several hours the rate of rise or fall of water level in the reservoir throughout the full range of variation of level which will be used in the turbine test. At the same time any leakage through the turbine head gates is to be measured. The surface elevation in the reservoir is not to be so affected by velocity or wind effects as to cause local variations in level of more than 5 per cent, of the total draw-down used in the turbine tests. This variation is to be observed by gages distributed over the whole reservoir, which are to be read simultaneously at short intervals through the test.

179 *Color Method.* When the water to be measured passes through a conduit suited to the purpose, the color method of quantity determination may be used. A solution or paste of coloring matter, commonly one of the aniline dyes, is injected into the conduit and the time required for it to pass through a known distance observed. This distance should be at least 200 times the mean velocity in feet per second. The coloring matter may be introduced as a paste at the intake to the conduit or it can be injected by a force pump or gun into the conduit at any convenient point. The particles of coloring matter will usually remain within a section having a length equal to 10 per cent of the distance traveled. Time observations should be made at the instant the coloring matter is introduced and at the first and last appearance of the coloring matter at the second point of observation. The mean rate of flow will be the volume included between the two points of observation divided by the mean of the two time intervals. If the conduit is not of uniform area it must be of sufficiently regular form to permit its volume to be accurately determined between the two stations.

180 This method may be very accurate if proper care is used in introducing the coloring matter to avoid any leakage of it into the water prior to the stated starting time, and to insure a prompt entraining of the entire amount by the body of the stream.

181 *Brine Velocity Method.* This method of measuring water is a modification of the color method, and is carried out by introducing in place of the coloring matter a concentrated salt brine or other chemical that is a good conductor of electricity. The time of passage of the brine is detected by the variation in electrical resistance indicated by a galvanometer which is connected to batteries and to an electrical circuit having poles inserted into the conduit at measured observation points. The galvanometer will show a stronger current while the prims containing the brine is passing the poles. This method has the advantage over the color method in that is it not necessary to see the water. The points of observation can be at any point in the conduit, as it will only be necessary to drill small holes in the pipe to insert the poles.

182 Experimental work now in progress indicates that this method of measuring water is capable of giving very accurate results (probably within 0.5 per cent of the true value) when properly used. (These experiments are being conducted by Prof. Chas. M. Allen, Worcester Polytechnic Institute.) Such tests as have been made lead to the conclusion that the time of maximum conductivity should be used; i.e., the time between the introduction of the brine and the time when maximum conductivity is indicated at the downstream station. It has also been found that it is possible and desirable to combine the two electrodes into a single fixture which can be inserted through one hole in the wall when used with closed conduits.

183 *Pressure—Time Method.* This method of determining the velocity of flow in a closed conduit is one recently invented by Norman R. Gibson, in which the changes of pressure in the conduit when closing a valve or the turbine gates are recorded by means of special apparatus. The record thus obtained results in a diagram called the "pressure time diagram" which, when properly interpreted, is a measure of the mean velocity that existed in the conduit prior to the interruption of flow. This method depends upon the principle that impulse is equal to momentum. A complete description of this method appears in Proceedings of the American Society of Civil Engineers, April, 1919, pages 173–206 and in Mechanical Engineering, April, 1921, pages 247–248.

HEAD-MEASURING AND PRESSURE-MEASURING APPARATUS

184 *Measuring Stick.* A good method for determining the elevation of the surface of flowing water is by direct observation. For surface determination in channels, a horizontal bar with its upper edge at a fixed or determined elevation, or a stretched wire, should extend across the race-way. The perpendicular distance from the upper edge of the bar or wire to the water surface should be measured at each station by means of a measuring stick with a graduated scale on its side. The graduations should preferably be marked so that the elevation of the water surface can be directly read off opposite the upper edge of the horizontal bar or wire at the instant the bottom of the measuring stick touches the surface of the water. An access bridge should be provided to facilitate measurements from the bar or wire.

185 *Float Gage.* For cases of great range of levels, a graduated tape, attached to a float and passing over a pulley, and provided with a suitable counterweight, makes a sensitive indicator.

186 For cases of small range of level, a graduated rod is attached to the float.

187 For flowing water the float must always be placed in a stilling box. (See Par. 189.)

188 *Hook Gage.* The hook gage consists of a sharp pointed hook attached to the lower end of a graduated rod, equipped with a vernier and sliding vertically in fixed supports. To take a reading on a water surface, the point of the hook is lowered below the surface and then slowly raised by a screw at the top of the instrument. Just before the point of the hook pierces the skin of the water surface a pimple is seen to rise above it; the vernier should be immediately read.

189 *Stilling Box.* Stilling boxes for use in connection with float, hook and other gages must be so constructed that they will not cause systematic

errors resulting from velocity effects and should, whenever possible, be open to full view of the observer, so that no errors due to sticking of the float may be introduced. For flowing water in open channels, the stilling box is placed outside the channel and communication is made by a small pipe, the end of which must be flush with the inside wall.

190 *Pressure Gage.* These gages are liable to error after having been in use for some time, especially when used with high or suddenly varying pressures, and should be frequently calibrated. Great care must be exercised in connecting dial pressure gages so that all air in the connection and the gage coil can be removed. There must be a point in the connecting pipe near the gage which is higher than the gage, and a petcock must be located at this point so that any entrained air may be removed. The gage must be so connected that it can be turned upside down while water is filling the connection, thus allowing the air in the gage coil to escape to the high point. The pressure observed then is that at the center of the gage dial.

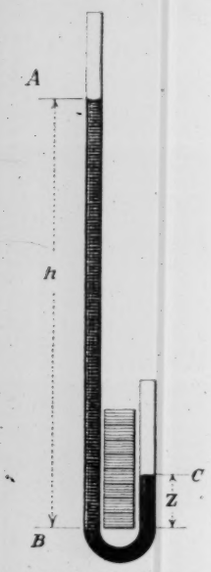


FIG. 109 SIMPLE MANOMETER

191 *Manometers.* The open liquid column manometer furnishes the most direct means of measuring the pressure head of water. Fig. 109 shows the principle of construction of such a gage. A bent glass tube ABC, with both ends open has mercury, or some other liquid heavier than water in its lower portion, the water column of a height h being balanced by the mercury or other liquid of height Z. If the atmospheric pressure at A and C are the same, then h (in feet of water) equals $s \times Z$, where s is the specific gravity of the indicating liquid. Obviously, water cannot be used as an indicating liquid because of the pressure pipes being filled with the same liquid. For measuring pressured heads between 1 and 50 feet of water, mercury should be used in the manometer. For measuring pressure heads less than 1 ft. of water, carbon tetrachloride or certain oils having specific gravities greater than 1.0 can be used instead of mercury to magnify the indication of the manometer. It is possible to get still further magnification by inclining the manometer or by using other magnifying devices such as gasometer gages, differential manometers using two liquids with different specific gravities, etc.

192 The manometer can be used to measure differential pressures by connecting the two ends of the bent tube to the two pressure pipes leading to the conduit or instrument containing the liquid under test.

193 Fig. 110 (a) shows a manometer used in an upright position and filled with mercury or some other liquid heavier than water. When filled with mercury a manometer so set up is suitable for measuring differential pressures between 1 and 50 ft. of water, which correspond approximately with 1 inch and 48 inches of mercury, respectively. For measuring differential pressures below 1 ft. of water the manometer should contain carbon tetrachloride (specific gravity 1.3 to 1.6) or some oil heavier than water in order to magnify the indications. Still further magnification can be obtained by inclining the gage or by using a gasometer gage. Because of the water above the indicating liquid in the manometer tubes the differential head h (in feet of water) equals $h' \times x(s-1.0)$, where h' is the measured head of the indicating liquid and s is its specific gravity.

194 Fig. 110 (b) shows an inverted manometer which when connected at D with a partial vacuum or a pressure above atmospheric, as the case may require, provides means for bringing the surface of the water in the pressure pipes or manometer within the glass tubes where the differential pressure can be read directly in feet or inches of water. In some cases it is desirable to magnify the indication by using kerosene or some other oil lighter than water and that will not mix with it, in the top of the manometer instead of air. The differential pressure head h (in feet of water) equals $h'(s-S)$, where h' is the measured head of the indicating liquid, s is its specific gravity, and S is the specific gravity of the material above the water in the top of the manometer.

SPEED MEASURING APPARATUS

195 *Hand Revolution Counter.* The hand revolution counter or speed counter consists of a small shaft pointed at one end and geared to operate the counting device. If handled carefully and well made it is a reliable type of instrument, particularly for speeds from 200 to 2000 r.p.m. As there is a possibility of introducing considerable error in making the measurement by not accurately gaging the time that the counter tip is put in contact with and breaks contact with the end of the shaft under test, it is desirable to make the period of contact between the counter and the shaft two or three minutes instead of for only a few seconds. If a $^1/_5$ second stop watch is used to time the period of contact and there is an error of only one scale division on the watch made in measuring the period of contact the error in the observed r.p.m. will be as follows:

Period of contact	Error in r.p.m. (per cent)
15 sec.	±1.33
30 sec.	±0.67
1 min.	±0.33
2 min.	±0.17
3 min.	±0.11

To prevent slipping of the point at high speeds, a rubber tip is sometimes used. If the tip is not true or the instrument is so held as to allow the axis of the counter shaft and the axis of the shaft being tested to be out of alignment there will be an appreciable error in the speed measurement, as the rubber tip under such conditions becomes a reducing gear of unknown and variable ratio.

196 *Revolution Recorder.* This instrument consists of a series of gears operating a set of dials indicating, by successive digits, the total number of revolutions. For accurate work this instrument should be connected to the rotating shaft by means of a positive clutch or equivalent device which will prevent slip. This form of instrument is not suited for speeds much over 250 r.p.m.

197 *Tachometer.* A tachometer indicates the instantaneous speed of a rotating shaft. If it is driven at the proper instrument speed through a set of gearing between the shaft under test and the instrument, it is suitable for measuring speeds from 6 to several thousand r.p.m. The use of gearing instead of pulleys and belts eliminates slip which may be a source of considerable error with belt driven tachometers. The instrument should be calibrated in any case.

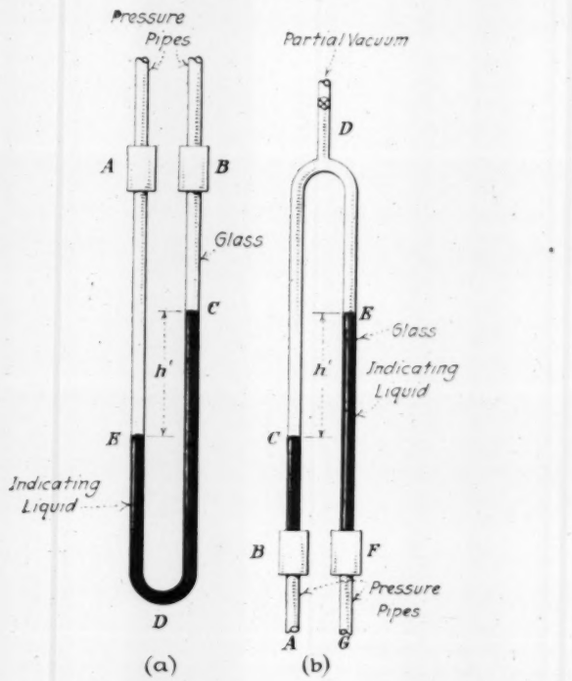


FIG. 110 MANOMETER FOR DIFFERENTIAL PRESSURES

Transactions of the International Engineering Congress, 1915, Now Available

The transactions of the International Engineering Congress which was held in San Francisco simultaneously with the Exposition celebrating the opening of the Panama Canal are now available through the Engineering Societies' Library. These papers form a valuable contribution to any collection of modern engineering literature, since the congress both in scope and in character, was truly international.

The entire set of these transactions consists of eleven bound volumes, having for their subjects, The Panama Canal, Waterways and Irrigation, Municipal Engineering, Railway Engineering, Materials of Engineering Construction, Mechanical Engineering, Electrical Engineering and Hydroelectric Power Development, Mining Engineering Metallurgy, Naval Architecture and Marine Engineering, and Miscellany. It is accompanied by an index volume which gives an historical and statistical account of the congress, abstracts of all the papers which were presented and a very usable table of contents and author index. With the exception of the volume on the Panama Canal the treatment given each subject has been in the nature of a broad survey with some special reference to important lines of engineering advance. The papers are accompanied by a bibliography of the literature of each subject so that the reader can extend his research into any one of the topics treated.

Only a few complete sets are left but the library has quite a large number of some of the individual volumes and papers which it will gladly supply to those who wish to purchase them.

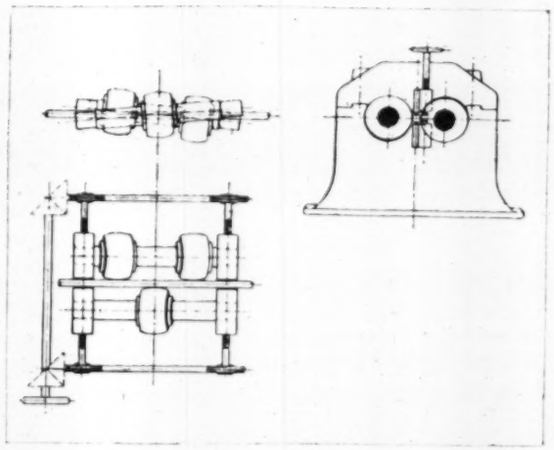
SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Friemel Cross-Rolling Mills

THE Friemel mills are designed for use on round iron, solid or hollow, where particularly high demands are made concerning the appearance and accuracy of measurement, and where a cross-rolling operation is effected after the main rolling process is finished. The Friemel cross-rolling mills are based on the same principle of operation as straightening machines, but differ from such cross-rolling mills as the Mannesmann inasmuch as the rolls are arranged not askew, but in parallel planes inclined to each other at certain angles determined by experiment.

The Friemel cross-rolling mills are chiefly used in the manufacture of tubes. The general effect of the machine is considerably enhanced by dividing one of the two rolls into two parts working on the same shaft, and then arranging the counter roll to fit into the gap between the two parts of the first roll (Figs. 1 to 3). With this arrangement of the rolls the material passing through the machine is forced to rotate around its own axis, and its exterior surface is subjected to a powerful treatment between the rolls.



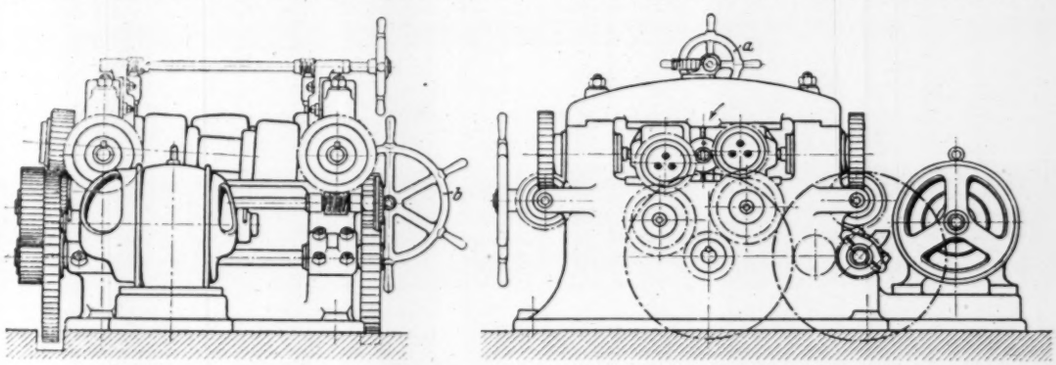
FIGS. 1 TO 3 ARRANGEMENT OF ROLLS IN A FRIEMEL CROSS-ROLLING MILL

It is claimed that the Friemel type of machine not only straightens the material but simultaneously unifies its diameter, and is therefore particularly suitable for finishing-off material intended to be worked later on turret lathes or automatic lathes. As the diameter of the entire piece is very uniform, no trouble is experienced afterwards in using conical grips or collets in machine tools.

Figs. 4 and 5 show a simple cross-rolling mill of the Friemel type. The machine has a powerful cast-iron frame, fitted with two guides for blocks containing the bearings of the rolls. On top the guides are covered over by strong lids, and between them the frame is designed in the shape of a trough, filled with water or oil as far as is necessary to let the rolls dip into the liquid. The blocks containing the bearings can be adjusted by means of screw-threaded spindles, particular care being taken in the design to make the blocks always move evenly toward the center of the machine, thus ensuring that the rod under treatment will never diverge from the exact center line of the machine in passing through it. The rolls must be adjusted in such a way as to exert a powerful pressure upon the rod which is being straightened.

Between the rolls, the material to be straightened is guided in so-called polishing guides of iron, gunmetal, or wood, depending upon the kind of metal treated, as well as the desired exterior appearance of the finished rod. With the machine under discussion these polishing guides can be adjusted with absolute accuracy with respect to the center of the machine, in a direction vertical to the plane in which the rolls move when being adjusted. The working ledges of these guides are arranged to permit of easy exchanging. Both adjustments are effected by hand by means of worm wheels and threaded spindles. The two rolls, arranged on a joint shaft, can be shifted about on the latter, thus permitting adapting the distance between them to the thickness of the material passing through. The cross-rolling mill described is provided with individual electric drive through an intermediate spur-wheel gear. In view of the whole nature of the design, it was impossible to avoid using bevel spur-wheels for the gear. As the spur-wheel gear, forming a complete unit with the rolling mill, does not work very efficiently owing to the unsatisfactory conditions prevailing at the bearings, it has become more and more usual to employ an arrangement involving the use of separate spindle housings and intermediate shafts with ball-and-socket joints. Of course, the initial cost of this arrangement is somewhat higher, but this is soon compensated by the resulting reduction in wear and tear.

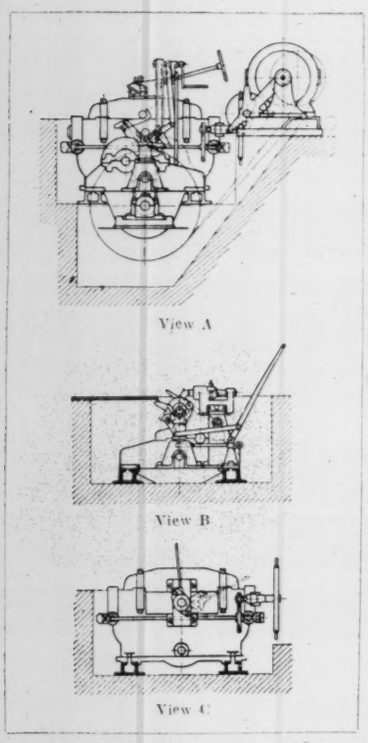
In addition to the actual Friemel cross-rolling mill, straightening plants of this kind also need guiding troughs. For small machines these simply consist of a strong angle or V-section, the latter being adjusted for height by means of threaded spindles; under ordinary circumstances this arrangement will fully serve its purpose. However, as a good deal of time is wasted in adjusting the various spindles separately, the troughs are frequently equipped with a joint drive for adjusting the spindles. To this end the nuts of the



FIGS. 4 AND 5 FRIEMEL CROSS-ROLLING MILL FOR ROUND IRON SECTIONS AND TUBES

spindles are fitted in worm wheels, the driving worms themselves on the other hand all being arranged on a joint shaft. A further improvement consists in the trough being provided with lids which can be turned up, an arrangement to be commended especially for the feeding trough. These lids are intended to prevent the rod from jumping out of the trough. Experience has proved that long rods particularly have a great tendency to behave in this way owing to their passing through the machine unstraightened, while simultaneously rotating at a comparatively high speed. This leads to the rods knocking and lashing about wildly.

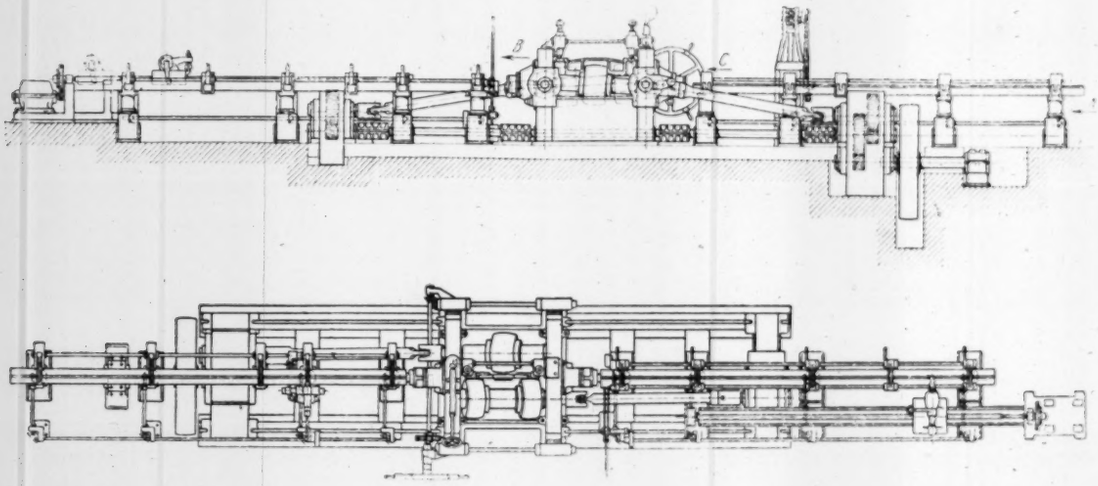
To handle the heavy rods in large machines, it is well to equip the delivery trough with a transferring appliance. The latter simply consists of levers cutting into the trough, and arranged to be swung out of the trough together with the rod. The operation of the levers can either be made by hand or mechanically, i.e., electrically or hydraulically, depending on the size of the plant and the output. With machines designed for straightening hot and heavy rods, an inserting device located alongside the feeding trough will facilitate operations materially. Such an inserting device consists of a sliding table on some kind of a guide, motion being imparted to it by a threaded spindle with electric drive. A bracket fastened to the slide (with a set of springs between) extends into the trough, where it presses the rod forward and into the machine.



FIGS. 8 TO 10 DETAIL VIEWS OF PARTS OF FIGS. 6 AND 7

Figs. 6 and 7 illustrate a Friemel machine of particularly powerful construction, designed for straightening highest-grade steel sections in the hot state, the machine being capable of dealing with sections up to diameter of 150 mm. (6 in.). The guiding troughs have a length of 6 m. (20 ft.) and the machine is driven by pinions and coupling pinions. A belt drive and jockey pulley are inserted between the driving gear proper and the motor. Most of the other special contrivances mentioned previously will also be found on this machine; but it has a common height adjustment for the spindles, raising and lowering the guiding troughs, turn-up lids on the troughs, as well as an inserting device.

The biggest Friemel cross-rolling mill hitherto built is capable of straightening tubes of ball-bearing steel in the cold state with an outside diameter up to 270 mm. (10.10 in.) and an internal diameter of 200 mm. (8 in.). This machine, which incidentally already possesses huge dimensions, was also provided with pinion drive and mechanical adjustment of the rolls. (*Engineering Progress*, vol. 3, no. 1, Jan., 1922, pp. 4–6, 12 figs., *d*)



FIGS. 6 AND 7 HEAVY FRIEMEL CROSS-ROLLING MILL FOR STRAIGHTENING SUPERFINE STEEL UP TO 150 MM. DIAMETER

Short Abstracts of the Month

AERONAUTICS

GOODYEAR GEAR-DRIVEN AIRSHIP. One of the important features of the new military airship built for the U. S. Army by the Goodyear Tire and Rubber Company is its gear drive from engine to propeller. In the past considerable difficulties have been experienced with such transmissions. There was heating up of the oil; excessive vibrations due to torsional reactions; and the tendency of the transmission to get out of step with the motors, resulting in excessive gear noise.

In designing the Goodyear transmission, it was decided to make the entire assembly one integral unit wherein the clutches, couplings, gears, shafts and propeller gear housing would be built together in the most direct manner. The transmission was designed with spiral bevel gears in which considerable experience was available in view of their popular use in the automobile industry. In the preliminary test run on a dynamometer it was found that there was an entire absence of gear hum and very little heating. To get an absolute measurement of efficiency of this unit, a large wooden stand was constructed upon which were mounted two Aero-marine 135-hp. motors with two clutches connected thereto, and additional elements to take up misalignment. A test load of 1000 lb. was hung on the propeller tip with the deflection of only 0.098. This was done to obtain an assurance that a propeller which weighs only 80 lb. would not cause any excessive bending movement on the transmission tube. (The tubes were cast of aluminum and heat treated.)

The transmission driven airship permits the motors to be placed within the car, thereby making them very accessible. In the case of non-rigid and semi-rigid airships, it permits Sirocco type fans to be attached directly to the motors, thereby permitting the elimination of scoops, which offer considerable resistance and add a large amount of weight. It permits any mechanical adjustments to the motors, and in the case of the above unit, a complete cylinder head could be removed while in flight. As the heating up in any transmission is a direct indication of power losses, due to the entire absence of this trouble in the Goodyear type transmission, it is conservatively estimated that an efficiency of 98 per cent is obtained

The fact that the propellers are 11 ft. in diameter, and have a pitch of 10 ft. 6 in., and also the reduction of head resistance and the absence of protruding members, should presage a considerable gain in the speed of the unit.

In view of the unit arrangement of the transmission, a reverse gear was inserted, permitting the propellers to be reversed without difficulty. The tractor-type propellers were so arranged as to permit the edge of the tube to be stream-lined. The radiators are to be set on bosses located on the tube, thereby placing them directly in the slip stream. The tractor type propellers offer the advantage of safety by keeping all these mechanical parts to the rear of the blade.

The characteristics of the unit are as follows:

Speed, m.p.h.	60
Rate of climb, ft. per min.	1000
Rate of descent, ft. per min.	800
Cruising radius—full throttle, hr.	14
Cruising radius—reduced throttle, hr.	20
Percentage of useful load	39
Length, ft.	170
Diameter, ft.	48
Crew	7

While this unit is an experimental airship, it has proven, a decided improvement in the non-rigid type of airship, even with the enclosed car, transmission, reverse feature and two additional passengers. Ships of this design could be constructed up to 300,000 cu. ft. capacity without the slightest difficulty. The entire design adapts itself to the insertion of a rigid keel, which would permit ships up to at least 1,000,000 cu. ft. to be built, with a saving in structural weights and increased useful lift. (*Aerial Age Weekly*, vol. 14, no. 20, Jan. 23, 1922, pp. 473–474 and 479, 2 figs., *d*)

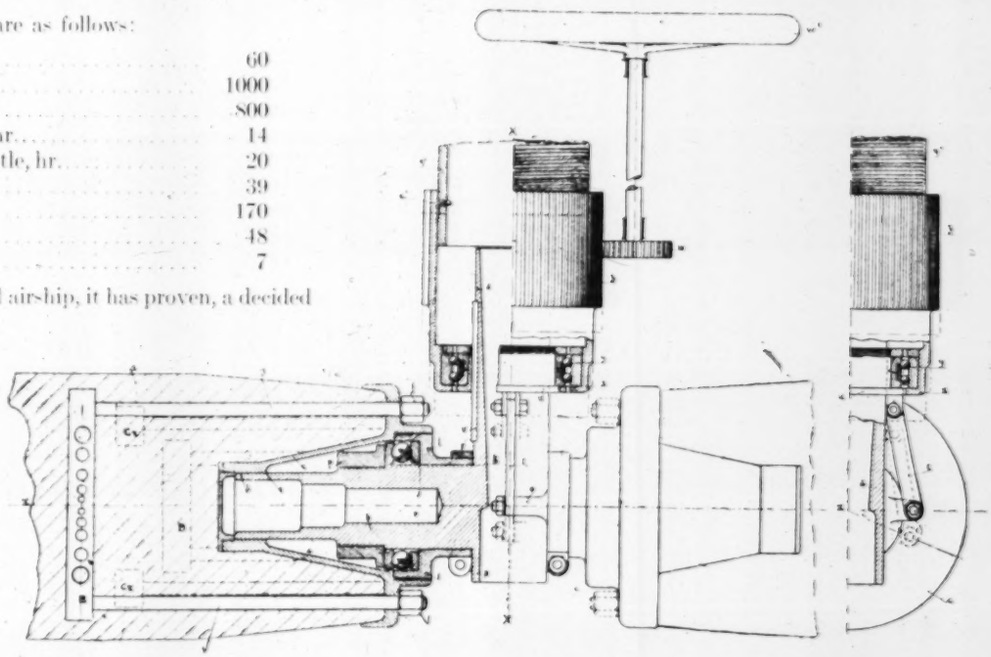


FIG. 1 LEVASSEUR VARIABLE-PITCH PROPELLER

Variable-Pitch Propeller

LEVASSEUR VARIABLE-PITCH PROPELLER. At the 1921 Aeronautical Exhibition in Paris, there was shown the variable-pitch propeller designed by Pierre Levasseur who has been identified with the aeronautical industry practically since its inception as an inventor and builder.

In the Levasseur variable-pitch propeller, the wooden hub is in compression from the inside instead of being held in compression from the outside.

The general view of the Levasseur propeller is shown in Fig. 1. The propeller blades are connected by anchor bolts, with castings mounted on lateral hollow shafts in the propeller hub. The pitch variation is carried out by displacement of these mountings on their respective shafts. The centrifugal forces are taken up by the ball bearing shown in the drawings.

Tests carried out in the laboratory of the School of Arts and Manufactures and at the Chalais-Meudon Field have shown that the new propeller gave satisfaction. The weight, at least in the first types, was somewhat greater than of a constant-pitch propeller, but a reduction is expected from an improvement in the design and material of the metal parts. A ten-hour test of the propeller run by a motor has shown that variations of pitch could be carried out under all conditions of operation without requiring any excessive muscular effort on the part of the pilot. It is pointed out that the development of the variable-pitch propeller will play an important part in the wider use of superchargers. (In this connection, attention may be called to the variable-pitch propeller developed at McCook Field, Dayton, Ohio, by the engineers of the Air Service of the United States Army and described in McCook Field and American Aeronautics, *Mechanical Engineering*, August, 1920, p. 442.) (*L'Aerophile*, vol. 29, nos. 23–24, Dec. 1–15, 1921, pp. 18–19, 2 figs., *dA*)

ENGINEERING MATERIALS (See also Machine Shop and Foundry)

A New Heat Resisting Alloy

CALITE, NEW HEAT-RESISTING ALLOY. It is stated that calite is a new alloy that melts at 2777 deg. fahr., softens at 2500 deg., and is safe to use at temperatures not exceeding 2200 deg. though it has been used at somewhat higher temperatures without bad results. Its specific heat is 0.123, thermal conductivity one-quarter that of iron, and elastic limit 36,800 lb. per sq. in.

Calite containers are used for carbonizing, annealing, heat treating and for the holding of molten lead, salts and cyanides.

From other sources information is available that calite readily casts into various shapes and can be ground, but is not suitable for machining. It should not be used in the presence of molten aluminum. No reliable data as to its composition are available. (*Coal Age*, vol. 21, no. 5, Feb. 2, 1922, p. 209, *d*)

HIGH-CARBON SEAMLESS STEEL TUBING, W. W. Hackett. Data on experiments made on aeroplane tubing during the war. It was found then that excellent results could be obtained by using 0.5 per cent carbon—steel tubing, giving in the bright or glue state a yield point of 40 to 45 tons per sq. in., and an ultimate stress of 45 to 50 tons per sq. in. In the motor trade there was a disinclination to use these high-carbon steel tubes, which it was thought would necessarily be brittle. No extra care had been used in heat treatment, but the results of hundreds of tests carried out showed that 0.3 per cent carbon was always better than 0.15 per cent, and 0.5 invariably superior to 0.3 per cent. Details were given of a number of these tests. In one series 20-gage tubing made of 0.54 per cent carbon steel had practically as long a life under the same weight and shocks as 17-gage tubing manufactured of 0.338 per cent carbon steel. Figures were given showing the greater strength of high-carbon than of medium- and low-carbon steels. One experiment showed that a 20-gage high-carbon steel was practically as strong as a 15-gage low-carbon steel, though only half as thick. This was attributed to the fact that after undergoing the brazing process the elastic limit of a 0.5 per cent carbon steel was about twice as high as that of a 0.15 per cent carbon steel at the brazed joint, and consequently the high-carbon steel was able to stand much more stress than the low-carbon. It was also concluded that the high-carbon quality had twice the life of a low-carbon when subjected to the same fatigue. (Paper read before the Joint Meeting of the Institution of Automobile Engineers and the Birm-

ingham Metallurgical Society. Abstracted through *Iron and Coal Trades Review*, vol. 104, no. 2811, Jan. 13, 1922, p. 42, *et*)

Manufacture and Properties of Steel Plates Containing Zirconium and Other Elements, Geo. K. Burgess and R. W. Woodward. This investigation originated from the need of the Ordnance Departments of the Army and Navy for information regarding the effects on the ballistic properties of light armor plate, of certain chemical elements, such as zirconium.

A joint program was outlined according to which the Bureau of Mines was to produce and analyze ingots of the desired compositions; the Bureau of Standards to manufacture and heat-treat plates, to carry out physical tests, micro-examinations and chemical analyses, and develop methods of chemical analysis, when needed, for the more unusual elements in steel and in the presence of each other; and the Navy Department to carry out the ballistic tests.

Although the results of the ballistic tests are not available for publication, an account of the mechanical properties and tests of this series of somewhat unusual steels was considered worthy of publication. These results may be summarized as follows:

About 193 heats of steel containing in various combinations the following principal variable elements; carbon, silicon, nickel, aluminum, titanium, zirconium, cerium, boron, copper, cobalt, uranium, molybdenum, chromium and tungsten, have been studied.

None of the steels presented any difficulties in rolling into plate except those containing boron.

The usual mechanical properties and impact tests were carried out on all the steels. It is shown that steel containing 0.40 to 0.50 per cent carbon, 1.00 to 1.50 per cent silicon, 3.00 to 3.25 per cent nickel, and 0.60 to 0.80 manganese, and deoxidized with a simple deoxidizer such as aluminum, can be produced having a tensile strength of approximately 300,000 lb. per sq. in. and with excellent ductility and toughness. This type of steel is recommended for a structural material.

Although the same high properties are obtained in steels of the above composition with the aid of additional elements, it does not appear necessary to resort to such additions of expensive alloying elements.

Zirconium, like titanium and aluminum, acts primarily as a scavenger, and when it is not removed as part of the slag it remains in the steel in the form of square bright yellow inclusions not directly visible at magnifications lower than 500 diameter. It is not considered that these inclusions can be very beneficial, and if they are segregated and rolled out into thin plate-like streaks they may be deterimental, especially in armor plate.

Of the other elements that are regarded as special alloying additions, chromium, tungsten, vanadium and molybdenum go into solution and produce a martensitic pattern in the air-cooled specimens. Cerium and uranium act in a similar manner but also show characteristic inclusions. Copper goes into solution but a larger amount is required to produce a martensitic-pattern in the air-cooled samples than for the others. Boron forms a complex eutectic, probably that of an iron-carbon-baron compound with iron. This eutectic is fusible at the temperatures ordinarily used in rolling, but at slightly lower temperatures steel containing boron can be rolled successfully. Hot working breaks up the eutectic and spherical hard particles, similar to iron carbide globules, are formed. (Abstract of *Technologic Paper No. 207 of the Bureau of Standards*, *e*)

FOUNDRY

Air and Electric Molding Machine. Description of a machine in which air is used for ramming the sand in the molds, and electricity for rolling the flask and afterward drawing the pattern.

The reason advanced for retaining the air-ramming device rather than electrifying the machine entirely is that air gives a cushion shock when the table drops.

A lever at one end which can be thrown into, or out of engagement with a cam slot determines whether the table automatically rolls over in its upward or downward travel, or remains in the original position. In the ordinary routine of operation, the lever is thrown into engagement at the same time, or a few seconds before, the motor is started to raise the table. The flask is located on the table to permit of a slightly over-balanced load, and the table is rolled on its approximate center of gravity. The table swings through an arc of 180 deg. on its upward travel and the remaining 180 deg. on the down trip. The lever then is thrown out of engagement and when the motor is started again the table is raised vertical and rigid while drawing the pattern. The action is positive and instantaneous, and may be regulated to produce the very slowest speed desired when starting the pattern. Then when the pattern has been loosened it may be raised to full speed at the will of the operator. The entire operation of rolling to the table or drawing the pattern is under the control of the operator at all times and may be stopped at any point. Automatic contact points are provided at rolled three stages—where the plungers have reached the limit of their stroke either up or down and where the flask comes to rest on the transfer car. At either of these three points the power is cut off and the motor is brought to rest by a quick-acting brake operated by electricity. (*The Foundry*, vol. 50, no. 2, Jan. 15, 1922, pp. 75–76, 1 fig., *d*)

German and British Experience with Synthetic Cast Iron

Synthetic Cast Iron. By synthetic cast iron is meant material produced by recarburizing steel. His article describes in particular a series of trials made at the Rombach Works in Germany during the war. In these trials a cupola of about 37½ in. diam. was used. It was charged with 2 tons of coke to a height of 7¾ in. above the tuyeres. After the blast was put on, more coke and 350 lb. burnt lime was charged. Then charges were put in, of 1100 lb. structural steel scrap, 200 lb. coke and 66 lb. lime, and with the first 5 tons of scrap, 900 lb. of 10 per cent ferrosilicon was charged. About three times the usual amount of slag was produced, and the slag was acid. Some runs were made without ferrosilicon but with more lime, ferrosilicon (110 lb., 75 per cent) being, however, added to the ladle when tapping.

In some of the tests the iron was too sluggish, and about one lb. of lime had to be added in each foundry ladle. In all cases it was found that the lining of the cupola was badly eaten away, the coke consumption was very high, and in addition to this, notwithstanding the high lime charge, high increase in sulphur was observed. The high coke consumption is due to the difficulty of melting low-carbon steel scrap in the cupola, and the high sulphur is due to the use of large amounts of coke.

If the coke consumption could be seriously reduced, then simultaneously all these difficulties could be removed. Liquid low-carbon metal was available from the steel works, and if the whole could be charged with molten iron the whole burden of melting would be removed, and only the carburizing remain.

On this hypothesis the following experiment was based: The first test was carried out in a pipe about 6½ ft. long and 3 ft. 3 in. diameter, lined with one layer of ladle brick and provided with a bottom and a taphole. Before each test a fire was made, the whole pipe filled with coke, and the whole blown as hot as possible. Molten low-carbon basic Bessemer metal was then poured into the white-hot column of coke in the pipe. In order to prevent pits being formed in the coke the ladle was moved slightly during pouring, the coke thrown continuously into the stream of metal.

During the pouring, or shortly before, ferrosilicon and manganese were added. Five minutes after the filling with the 5 or 6 tons of molten metal, the taphole was opened and the metal teemed into the molds. The resultant iron was examined chemically and microscopically to ascertain whether the carbon was really combined, and not simply mechanically mixed with the iron. The results on several casts are shown in Table 1.

TABLE 1 SHOWING THE ANALYSES OF LIQUID STEEL RUN THROUGH A COLUMN OF COKE CONTAINED IN A PIPE

Si.	Mn.	Ph.	S.	C.
0.07	0.24	0.05	0.08	1.95
0.60	0.53	0.15	0.08	1.70
0.80	0.58	0.19	0.09	1.70
0.36	0.53	0.10	0.08	2.52

Similar results have been obtained with the corresponding tests carried out over a period of eight months. Only traces of mechanically included carbon have been found. The iron is extremely tough and shows a martensitic structure. The increase in phosphorus is interesting; an investigation showed this came from the slag carried over by the metal.

These experiments show that the metal must be hot and fluid, and the coke column thoroughly heated. Then there is no danger of the metal solidifying inside the coke column.

From the experience gained, a furnace similar to a cupola was built near the foundry-ladle track. At the charging-floor level, the furnace was equipped with a large door for charging coke on one side, and on the other side with a launder for the molten metal.

The furnace was provided with two sets of tuyeres and oil burners, through which blast could be blown for heating the coke. A receiver of about 25 tons capacity, heated with two tar-oil burners was provided. In front of the taphole lay the casting bed.

The *modus operandi* is to heat the receiver, and the hot gases ignite the coke in the shaft. As soon as the receiver and column of coke are sufficiently hot, a ladle of basic Bessemer steel is brought along and slowly poured down the launder, the charging door being kept closed. The metal runs down into the receiver, where it is mixed. Sometimes the process is carried out with the receiver taphole open so that the metal simply flows through it, but even this gives a uniform metal, the difference in carbon between the first and last cast being only 0.20 per cent. As soon as the metal is cast the shaft is refilled, and the furnace prepared for the next cast. Metal made in this way contains usually 2.6 to 2.8 per cent carbon, and corresponds to the so-called low-carbon special iron. The great toughness of this material is due to the metal being carburized at comparatively low temperatures.

Comparative synthetic tests with the Rombach synthetic pig iron, produced by the above process, and with Swedish charcoal pig iron, show that as produced experimentally the Rombach iron may be used as a substitute for the Swedish iron. However, the great advantage of the Swedish iron lies in its uniformity, and whether the same uniformity can be attained in the synthetic pig iron under commercial methods of production remains to be proved. The serious drawback of the Rombach iron is its spongy and rough appearance, which has not yet been eliminated. (*The Foundry Trade Journal*, vol. 25, no. 282, Jan. 12, 1922, pp. 29–30, *e*)

In this relation, attention is called to an editorial in the same issue (p. 25) to which reference is made to other processes of synthetic-pig-iron production developed during the war, primarily in Italy and France where cheap electric power and very large amounts of steel turnings were available at a time of great shortage of pig iron. In Great Britain there was another difficulty, namely, the shortage of Swedish white pig iron, which is one of the bases of Sheffield tool-steel manufacture. For making a synthetic iron in this case a most rigid specification had to be met, namely, sulphur and phosphorus below 0.02 per cent.

The manufacture of synthetic white pig iron of Swedish quality was investigated by Victor Stobie of Dunston-on-Tyne. Realizing that the intense reduction of the sulphurs associated with the building up of the carbon content meant the establishment of powerful reducing conditions, Mr. Stobie doubted whether the most expert slagging-off of the slag from a phosphorus-free bath could be accompanied sufficiently well to prevent the phosphorus from passing the 0.02 per cent mark on the introduction of reducing conditions. He therefore constructed two 20-ton stationary electric furnaces at two levels. The primary furnace, on the higher level, was the one in which melting and the refining based on oxidizing reactions was conducted; when the metal had been refined to the usual "slagging-off period" composition of C. 0.07, Si. 0.02, P. 0.009 and S. 0.03 to 0.06 per cent, a taphole was opened and the metal allowed to run into the secondary furnace, the slag on its appearance being diverted by a Y-shaped runner. In the secondary furnace the metal met an excess of pure carbon and lime, which set up intensely reducing conditions seldom met with in workshop metallurgy. No difficulty was experienced in reducing the sulphur to well within the limit, but though the phosphorus specification of 0.02 per cent was usually met, there was the same increase in phosphorus noted by the Rombach firm. In both this and Mr. Stobie's process the phosphoric slag will contain between 20 and 35 per cent of metallic iron, while the metal with which it is associated contains an unknown but possibly very high quantity of gas. Obviously, in the cold there would be a strong differentiation in the specific gravities of the two, but at steel-making temperatures they appear to be sufficiently near one another as to be at least partially miscible. Important progress in this line of work was made in France.

FUELS AND FIRING (See also Internal-Combustion Engineering)

GAS ENGINEERING

GAS MADE BY CARBONIZING STRAW, Harry E. Roethe. Description of the experimental unit installed on the Government farms at Arlington, Va., to be used by the Bureau of Chemistry. The retort is charged with unbaled straw through two oval openings at the front end, after which covered plates are tightly clamped in place. The heat is applied to the retort from beneath by the straw or wood in the firebox. Gas begins to come off when a temperature of about 200 deg. cent. (392 deg. fahr.) is reached, with the maximum production between 500 and 600 deg. cent. (932 and 1112 deg. fahr.).

Tests have shown that straw gas gives a very good light when

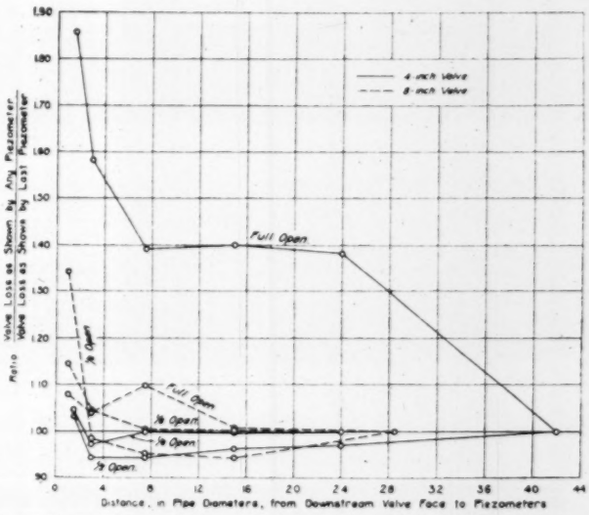


FIG. 2 RESULTS OF EXPERIMENTS ON RELATION BETWEEN PIEZOMETER LOCATION AND MEASUREMENT OF VALVE LOSS

used in gas mantle lamps, and that its use in gas hot-plates, stoves and heaters is very satisfactory. Excellent results have been obtained with the gas as a source of power for operating stationary internal-combustion engines. In this connection the gas apparently proves most satisfactory when mixed with little air and ignited under a compression slightly greater than that found in the ordinary stationary gasoline engine.

The article cites statistics which would indicate that important amounts of power could be secured from that material. (*Gas Age-Record*, vol. 49, no. 3, Jan. 21, 1922, pp. 75–76, 2 figs., *g*)

HOISTING MACHINERY (See Machine Parts and Design)

HYDRAULICS

Piezometer Location and Measurement of Valve Loss

MEASUREMENT OF VALVE LOSS AS AFFECTED BY PIEZOMETER LOCATION. Data of experiments carried out at the University of Wisconsin during the school year 1919–20 by M. C. Neel and C. A. Willson, thesis students, with a 4-in. and an 8-in. gate valve to determine the influence of the location of piezometer on the measurement of loss of head due to a valve.

The various piezometer openings along each main pipe were connected to a differential-gage board where the head differences could be read. The apparatus was first set up in each case without the valve in place, and the loss of head due to pipe friction only was determined. The valve was then inserted and the loss for valve and pipe determined for a number of valve openings. The results from $^1/_8$, $^1/_2$ and wide open conditions for both valves (4-in. and 8-in.) are shown in Fig. 2. From this it would appear that piezometers located within 3 diameters distance from the valve show in every

case an excessively large loss, and that in the region from 3 to 15 diameters downstream the disturbance of flow has caused the piezometers to register in an uncertain way.

Another figure in the original article appears to indicate that the loss is different from the normal pipe-friction loss for 40 or more diameters downstream, but when a point from 15 to 20 diameters has been passed this loss is negligible from a practical standpoint. It would also appear that there is in a section of the pipe a partial reconversion of the velocity head back into pressure head, indicated by a negative value of the loss. It is concluded that a valve causes disturbed flow in the pipeline downstream for some distance from it, and that a Piezometer opening, which is connected so as to be in this region, will be affected giving a false record of pressure within the pipe. It would appear, therefore, that the true loss is indicated only by the piezometer located at least 15 or 20 diameters of straight pipe from the valve. (*The Wisconsin Engineer*, vol. 26, no. 4, Jan., 1922, pp. 61–62, 4 figs., *e*)

INTERNAL-COMBUSTION ENGINEERING (See Railroad Engineering)

Deutz Compressorless Diesel Engine

The New Deutz Compressorless Diesel Engine, Schneider. The article is partly historical and partly descriptive. It describes and illustrates the new Deutz engine, as shown by a German patent application which has recently been vigorously and unsuccessfully contested, and also gives the previous history of the development of the art as shown by the patents to Brandis (1910 and following).

The Deutz compressorless Diesel engine is built horizontal,

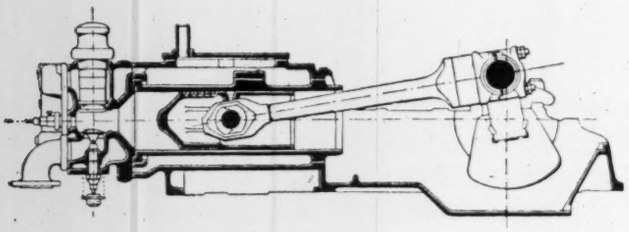


Fig. 3 Deutz Compressorless Diesel Engine

single-acting, 4-stroke cycle. The single-cylinder type is built in sizes of 8 to 100 hp. output and the double-cylinder for outputs from 130 to 250 hp. The basic principle of the design of this type of compressor is that an auxiliary element is used, usually placed at the end of the working cylinder and so arranged that it acts as an injector for the fuel. As shown in Fig. 3 this is effected in the following manner. A "restricted space" is provided between the cylinder proper and the combustion chamber, this restricted space is so shaped that the air flowing through it towards the combustion space moves, in the direction of the left front wall of the latter, in the form of a cone, the apex of which is located somewhere near the fuel-injection tube. The fuel-injection valve is extremely simple and no air-admission passages are needed. Neither are there any injection-valve needle, compressed-air injection flasks and the other accessories of compressed-air fuel-injection systems, which simplifies the entire design in a very material manner. (*Oel-u. Gasmachine, Motor Fahrzeuge*, vol. 18, no. 12, Dec., 1921, pp. 186–188, 4 figs., *hd*)

Kraus Fuel Oil Engine. The Kraus oil engine is an internal-combustion engine in which air is compressed in separate compression cylinders, mixed with the jet of atomized oil and ignited by an electric spark. Once this jet of gas has become ignited, it burns continuously and the resulting hot flame is brought into contact with small quantities of water which cool the gases to a working temperature. At the same time steam is generated, which, combined with the gases of combustion enters the power cylinders and performs work upon the pistons. This results in elimination of hot gases and excessive temperatures within the working cylinders. No special light fuel for starting is used, starting being accomplished directly with the oil without any previous heating by means of hand or mechanical cranking. Only one spark plug is used, and this only for igniting the initial jet of gas at the beginning of operations. Once this has been lighted it is no longer necessary. The motor is controlled by a simple throttle valve.

As regards water jackets, the cooling water enters the exhaust manifold, passes around the working cylinders and when heated to practically the boiling point, is admitted into the gas jet and converted to steam as mentioned before.

No experimental data as to power developed, fuel efficiency, amount of water used, etc., are given. The engine was exhibited at the Motor Boat Show in February, 1922, in New York City. (*Motor Boating*, Show Issue, Feb., 1922, p. 33, 1 fig., *d*)

Burning Mixtures of Alcohol and Gasoline in Internal-Combustion Engines. During the war the question of fuel for internal-combustion engines, especially those of the the automobile type, became a very acute one in France. Gasoline had to be imported from afar and it became necessary to determine whether fuel from some other sources could not be substituted for it or at least used to supplement its supplies. Even though no very large quantities of alcohol were in sight, it was decided that it would be desirable to determine the combustibility in automobile motors of mixtures of alcohol and gasoline, if only for use at some later date. The Department of Inventions asked to have this question investigated at the laboratory of the Technical Division of the Artillery, at that time under the command of Colonel Nicholardot. A report was prepared on the subject by this officer, well known as chemist and scientist, and the present article is a reprint of that memorandum. (Regarding the means by which this memorandum fell into the hands of the publishers, the latter state that they prefer to be silent in order to protect the vanities of certain French military services.)

The report investigates the following subjects: Variation of solubility of 90 per cent industrial alcohol in gasoline as determined by temperature; variation of solubility of alcohol as determined by the percentage of pure alcohol at ordinary temperatures, and for industrial alcohol, variation of solubility produced by the addition of certain quantities of ether, benzene, and benzol. Data of tests are given in the form of tables and curves.

The author comes to the conclusion that the minimum temperature at which the homogeneous system alcohol-American gasoline-benzol may exist, rises very rapidly with the water content of the alcohol. This immediately suggests a practical point, namely, that containers in which such mixtures are produced should be either carefully dried or rinsed in alcohol, the latter being then recovered. For an alcohol of a given degree of strength, the above minimum temperature of homogeneity is the lower, the greater the proportion of alcohol, the lighter the gasoline and the less the content of higher homologues (toluene, etc.) in the benzol. (*La Technique Automobile et Aerienne*, vol. 12, no. 115, 4th quarter of 1921, pp. 116–124, 6 figs., to be continued *et*)

MACHINE PARTS AND DESIGN

Double Helical Gearing, H. H. Broughton. Data on the strength of helical gearing, and particulars of a number of individual gears used for winders and haulages. In the original article two extensive tables give technical data of a number of helical gears that have been actually used, one of the tables referring to Citroen gears and the other to gears made by the Power Plant Company in England.

A typical split wheel is shown, to illustrate the method of registering the two halves by means of tool steel ferrules located at opposite ends of a diameter.

For a helical or herringbone gear of given dimensions, the moment of inertia of the teeth may be figured as 40 per cent of a hollow cylinder of the limiting dimensions, and the rim (exclusive of teeth) may be figured as a hollow cylinder. Adding 25 per cent of the sum of these two moments of inertia will make the necessary allowance for the hub and arms of the wheel. If the weight and pitch diameter only are given, the moment of inertia may be considered to be the moment of inertia due to 60 per cent of the total weight concentrated at the pitch circle. A numerical example of calculation is given. Concerning gears made by various manufacturers in England, the

author points out that the tooth, pitch and width of the wheels transmitting a given amount of power for a definite speed are by no means standardized, and a comparison of gears by four different makers is given which shows the very wide variation in practice. In particular, it is pointed out that not only is a different formula used for designing the pitch but different factors of safety are also employed. (The product of pitch and width varies directly as the factor of safety.) Thus, until quite recently one firm made it a practice to allow a factor of safety of 10 on peak loads, which corresponds to a factor of 15.5 on the rated horsepower of the motor. It should be remembered, however, that such high factors are necessary for securing durability and not actual strength or safety, so that really a durability factor, as distinct from a safety factor, is introduced. By adopting improved methods of manufacture and by careful selection of pinion material, a factor of safety of 5 or 6, reckoned on peak loads, may be regarded as sufficient to ensure satisfactory service.

A remarkable thing brought out by Table IV is that the cost of gears quoted by four firms to the same specification varied from 1183 to as high as 2875 pounds sterling. (*The Electrician*, vol. 88, no. 2278, Jan. 13, 1922, pp. 34–37, 1 fig., *dpc*) Serial article.

MACHINE SHOP

Making Spur Gears by Grinding

GRINDING HARDENED GEAR TEETH. Description of the machinery and processes developed by a British concern (The Gear Grinding Co., Ltd., Handsworth, Birmingham, England) for finish-grinding spur-gear teeth to within definite limits of accuracy.

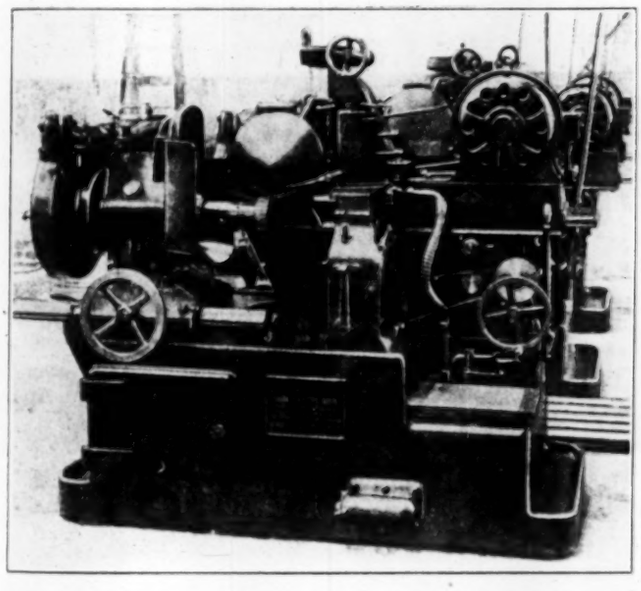


FIG. 4 GENERAL VIEW OF MACHINE FOR FINISH GRINDING SPUR GEAR TEETH

This grinding is done, of course, after heat treating, and it is stated that the finish on the surface of the work and the results obtained are far superior to the usual finishing of gear teeth with a hardened cutter.

In the present system, gashing the teeth has been reduced to a rough-milling operation, leaving on both sides of the tooth for finish grinding from 0.012 to 0.018 in. on small gears such as used in automobile gear boxes, and from 0.040 in. to 0.060 in. on large gears.

The machine is shown in Fig. 4. Briefly, the principle of operation consists of forming the edges of the grinding wheel to the desired profile of the gears being ground, and of controlling that form throughout the operation by trimming as the wheel becomes worn. In actual practice this is only necessary after the rough grinding has been completed. The bed of the machine has a reciprocating carriage at the rear, on which is mounted the wheel head. This carriage is driven by a link action, while the wheel head is fitted to a vertical slide in such a manner that end play is eliminated and the wheel head is only moved after retrimming the wheel as the cut is applied by raising the work to the wheel.

The work arbor is carried on the head shown to the left, and this also embodies the dividing mechanism for bringing each tooth into position. Both longitudinal and vertical adjustments are provided for this head—one for bringing the gear teeth into the desired position in relation to the traverse of the wheel-head, and the other for regulating the depth of cut.

This adjustment is very fine and is so arranged that extreme accuracy may be attained, and when the teeth on the first wheel of a batch have been ground to the correct depth, uniformity can be maintained throughout by working to the same setting.

It will be obvious that the degree of success obtained in the finished product depends to a great extent upon the efficiency of the indexing mechanism in the direction of precision and positive locking. A separate index-plate is, of course, required for different gears, and these are fitted to the end of the work arbor by a special type of holder which enables the notches to be set on either side in relation to the locking pawl, thereby reducing the stroke of the indexing pawl to a minimum.

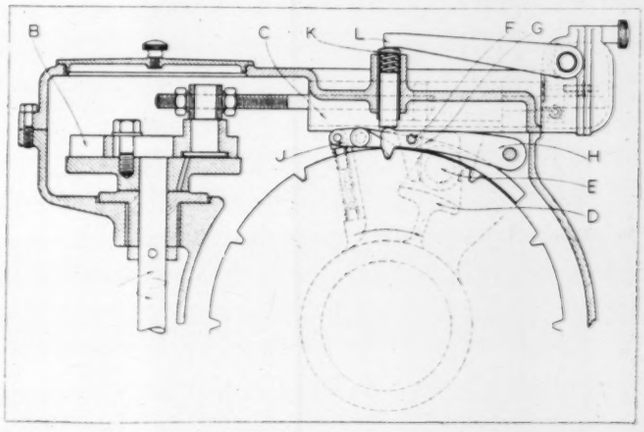


FIG. 5 INDEXING MECHANISM FOR TRIMMING GRINDING WHEELS OF GEAR GRINDING MACHINE

A detailed view of this motion is shown in Fig. 5. This mechanism is actuated through the medium of the shaft *A* and the crank disk *B*, in conjunction with the sliding member *C*, which in turn operates the arm *D* through the pin *E*. Arrangements are made so that each revolution of the crank disk is synchronized with the traverse of the wheel carriage.

The dividing plate revolves in the direction indicated by the arrow, while the lever *D* travels in the opposite direction, and by reason of the small pin *F*, running on the cam face *G*, the locking pawl *H* is withdrawn from the notch, and is retained in the "open" position until the return stroke commences.

Moving simultaneously with the member *G* is the indexing pawl *J* and at the termination of the outward stroke it drops into the next notch, thus pulling the index-plate round one division on the return stroke, at the end of which the locking pawl is in its correct position over the notch. It is then pushed in by the action of the spring plunger *K*, and simultaneously the swinging lever *L* is brought into contact with the end of the plunger, firmly locking the whole mechanism until the end of the cutting stroke of the grinding wheel.

The length of stroke given the indexing pawl is regulated by moving the stud along the slot in the crank disk, while final setting is obtained by the nuts at the end of screwed portion of the sliding member *C*.

The wheel-trimming device consists of three diamonds, two arranged for trimming the concave flank edges of the grinding wheel and one for dealing with the edge that cuts on the bottom of the teeth. Means are provided to compensate for the receding of the edges of the wheel from the datum line as the wheel wears. Hitherto only spur gear wheels have been ground. It is stated that the machines here described are not made for sale, but to be used for

production purposes by the manufacturers themselves. (*Engineering Production*, vol. 4, no. 67, Jan. 12, 1922, pp. 42–44, 6 figs., *d*)

MARINE ENGINEERING (See Steam Engineering)

The Bassett Process of Direct Manufacture of Steel from the Ore, Fritz Wuest. General discussion of the Bassett process, based on an address made by the author before the meeting of the Verein deutsche Eisenhuettenleute, November 26, 1921.

The article discusses the history of the effort to produce steel direct from the ore, and concludes that the process described cannot be carried out without losing in the slag a material part of the reduced iron. Furthermore, it is stated that the Bassett process is as little capable of securing complete reduction of metal from ore as the former processes for the direct reduction of steel. (*Stahl und Eisen*, vol. 41, no. 51, Dec. 22, 1921, pp. 1841–1848, 4 figs., *g*)

POWER-PLANT ENGINEERING

Pioneer Boilers Fired with Pulverized Coal, F. P. Coffin. An article on the history of the firing of boilers with pulverized coal. Among others, the author mentions the Bettington boiler, the boiler of the Erie City Iron Works, and of the American Locomotive Works.

Mention is made also of some of the work done in South America. (The Utilization of Coal on a Multiple Product Basis in Bacon and Hamor's book "American Fuels," abstracted through *Combustion*, vol. 6, no. 2, Feb., 1922, pp. 74–77 and 95, 2 figs., *h*)

Baffle Bridge for Cleaning Fire Under Boilers

The Gallagher-Crompton Baffle Bridge. A device for assisting in cleaning out fires under boilers.

The appliance consists of an extended platform of firebrick behind the grate, supported by standard sectional castings adapted to particular size of flue and type of grate, and inclining upwards towards the rear. The method of operation is as follows:

Without being previously burned down, the live fuel on the grate is pushed back by means of a rake on to the baffle bridge, and is there piled up, almost completely blocking the flue. The effect of this is that the cold air is prevented from entering the flues in large quantities, and combustion continues to a limited extent on the bridge. Thus the cooling of the flues is minimized and a higher

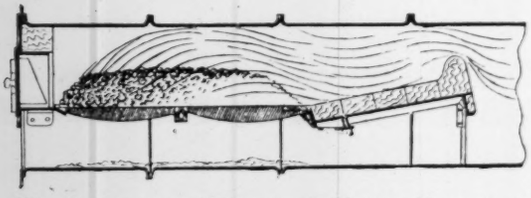


Fig. 6 Condition of Fire under Normal Methods of Cleaning

percentage of CO_2 maintained. Further, the furnace door can be closed and the fire left in this condition for several minutes to allow the combustible remaining on the grate with the clinker to be burned off. The clinker and ash are now readily removed, and as the operations of the fireman are not hampered by the presence of live fuel on the grate, he is able to remove them more quickly and thoroughly than by the ordinary methods.

The next operation is to draw the live fuel forward again and redistribute it over the grate. Here again the baffle bridge offers advantages, for it is possible to save a much larger and hotter body of live fuel, thus enabling the firemen to recover normal furnace conditions in minimum time. Fig. 6 illustrates the condition of the fire under normal conditions, and Fig. 7 when the fire is pushed back ready for the clinker to be removed.

In tests in two plants, each comprising two Lancashire boilers and one plant equipped with the baffle bridges, it is claimed that an important saving in fuel was effected, notwithstanding the fact that in the plant equipped with baffle bridges only coke breeze was used, while the plant not so equipped used a mixture of coal and coke breeze. (*Iron and Coal Trades Review*, vol. 104, no. 2811, Jan. 13, 1922, p. 46, 3 figs., *d*)

RAILROAD ENGINEERING

Gasoline Switch Locomotive, L. C. Josephs, Jr. Description of a light-type switching locomotive, built by the International Motor Company, with many parts standard in the Mack trucks.

The locomotive is of the common steeple-cab type, with an engine located longitudinally at each end and an operating cab between, and the transmission located below the floor of the cab.

As the new engines face in opposite directions, their rotations are opposite. They are arranged, therefore, to drive through the regular clutch assemblies and bevel pinions to the opposite sides of the bevel gear on a shaft mounted across the locomotive. Thus, either one or both engines may be used as required, the clutches being controlled by adjacent pedals at the operating position. From this main bevel the drive passes through a simple reverser of the spur gear and jaw clutch type to the transmission. The driven end of this transmission carries a spur pinion geared to a cross jackshaft below, while the jackshaft carries four small sprockets and drives the locomotive axles by two 2-in. roller chains to each axle.

The locomotive on its initial test was able to start and accelerate the 600-ton train on level track. (*Railway Review*, vol. 70, no. 3, Jan. 21, 1922, pp. 82–84, 4 figs., *d*)

Railroading in Siberia, Col. Benj. O. Johnson. General discussion of the situation in Asiatic Russia. The following report is cited to give a sample of railroading under difficulties.

"The report received this morning from Pogranichya is to the effect that there was a bridge blown up at 4.30 a.m. on Ussury Ry., between Horvatovo and Lipovtzy stations. The track is damaged and eight wooden braces and the bridge foundation are also damaged, with the span in direction of Horvatovo brought down. Train No. 4 departed from Talovka on 72nd verst,[1] was fired upon, and one second-class passenger wounded. While train No. 4 was running between Horvatovo and Talovka, on the rear of the train there were heard two strong explosions. The location of these explosions is being ascertained. Train No. 4 is located at Horvatovo where it will remain awaiting completion of repairs on bridge on 53rd verst, and information as to explosions in the rear of the train. It is understood that the repaired bridge between Horvatovo and Talovka is again blown up. (*The Journal of the Worcester Polytechnic Institute*, vol. 25, no. 2, Jan., 1922, pp. 81–83, *g*)

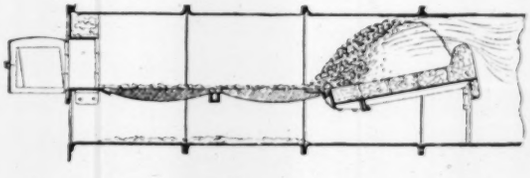


Fig. 7 Condition of Fire when Removing Clinker with Baffle Bridge

SPECIAL MACHINERY

Cutting Metal Under Water by Acetylene Torch

Blow Pipe for Under Water Working. British Patent No. 168,929, blow pipe, designed primarily to enable oxyacetylene welding and cutting to be carried out under water. Briefly, the principle consists in utilizing compressed air to form a water-free zone around the flame of the blow pipe. The essential part is a casing having internal spiral vanes arranged so that compressed air, in passing from the rear of the casing, issues around the nozzle with a cyclonic or spiral effect, giving a region of maximum pressure at a point below the nozzle. For mounting the casing, a back plate is attached to the burner by means of a union nut, while the plate itself carries an internally screwed ring, which may be rotated to provide axial adjustment for the casing without rotation of this member relatively to the burner.

A pipe secured to the stem of the blow pipe supplies the compressed air to the space at the rear of the casing, suitable ports being provided as shown. The burner is then completed by a cup-shaped cap screwed to the outer end of the casing, and this cap may have a

[1] One verst = two-thirds of a mile.

series of recesses across the outer edge, or it may be provided with projections to prevent the face from being pressed into close contact with the work. (Abstracted through *Engineering Production*, vol. 4, no. 66, Jan. 5, 1922, p. 21, 1 fig., *d*)

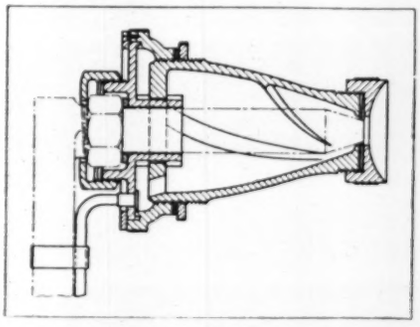


FIG. 8 BLOW PIPE FOR OXYACETYLENE WELDING AND CUTTING UNDER WATER

STEAM ENGINEERING

Hawthorn-Armstrong Marine Water-Tube Boiler with Superheater

HAWTHORN-ARMSTRONG WATER-TUBE BOILER FOR MERCHANT SHIPS. The purpose of the new boiler is to combine the steam generator and the superheater in one unit. Apart from the superheater elements, the new boiler has the main characteristics of the Yarrow type, but is provided with larger water surfaces and steam spaces than is usual in water-tube boilers of the ordinary type. Also, the circulation in evaporating elements is always continuous and in one direction, the outside tubes forming downcomers and thus establishing a figure-eight circulation through the cross tubes at high velocity, which scours the insides and prevents deposit even with poor feedwater.

The construction, Fig. 9, consists of four drums, *A*, which, together with the $1^{3}/_{4}$-in. diameter tubes, *B*, form the evaporating unit connected together crosswise by the tubes interlaced with each other, and three rows of downcomer tubes *C* which form the water wall at the sides.

The combustion chamber is formed under the evaporating tubes *BB*, and between the two lower water pockets *AA*.

Incorporated with the evaporating unit are the superheating tubes *FF*, which are connected to the two lower pockets *GG*, and one large central steam drum *F*, the latter being divided into three parts, *JJK*, the middle portion *K* being the superheat container, and the two wing portions *JJ* forming the passage, by way of the pipes *NN*, for saturated steam down to the lower pockets *GG* of the superheater through a portion of the tube and rising up to the central portion of the drum through the remainder of the superheating tubes *FF*, the steam being superheated in its passage through the small tubes *FF*. These tubes are 1 in. in diameter.

The experiment was made with the boiler worked with auxiliary feed make-up from water containing a large proportion of chalk and lime in solution, and also from sea water. After three weeks of continuous run the boiler was opened up; all the deposit was found in the lower drums and nothing in the tubes.

The arrangement of the superheater element is such that by manipulating three stop valves this portion can be converted into a saturated steam producer, either to supplement the total steam supply or as a precaution against damage to superheater tubes when lying under banked fires or when working engines in or out of port; that is, when little or no circulation takes place in the superheater tubes. (*The Marine Engineer and Naval Architect*, vol. 45, no. 532, Jan., 1922, pp. 10–11 and 40, 2 figs., *d*)

TESTING AND MEASUREMENTS (See Hydraulics)

THE APPLICATION OF THE ULTRA-MICROMETER TO THE MEASUREMENT OF SMALL INCREMENTS OF TEMPERATURE, W. Sucksmith. The ultra-micrometer invented by Prof. R. Whiddington was described in *Mechanical Engineering*, Jan., 1921, p. 49. It is an instrument working with two oscillating valve circuits and measuring up to one-two-hundredth of a millionth part of an inch. In one of the circuits there is a condenser consisting of two parallel plates, and the variation in the distance of these plates produces variations in the note emitted from a telephone, thus affording a basis of measurement.

In the present experiments the method used was to attach a metal bar or tube to one of the condenser plates and measure change in the temperature of the bar by the change in the note produced in the telephone which in turn was produced by the change in length of the bar. The original article describes the installation in detail. The copper tube on which the measurement was made was heated

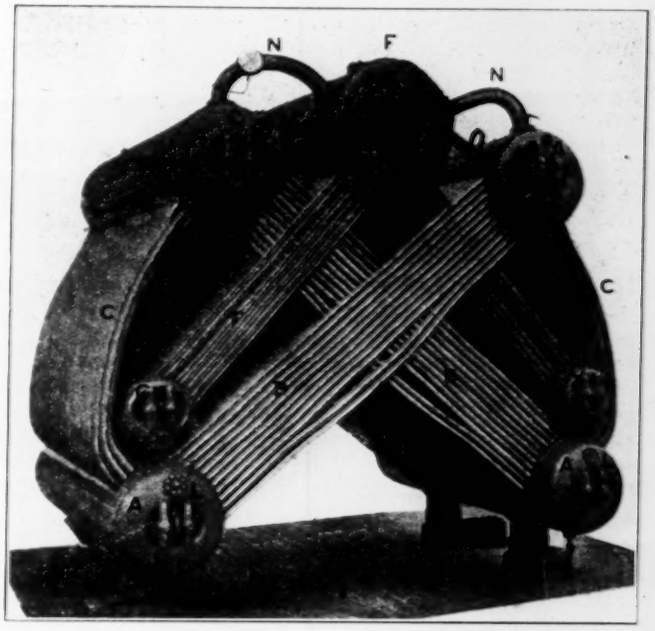


FIG. 9 HAWTHORN-ARMSTRONG MARINE WATER-TUBE BOILER WITH SUPERHEATER ELEMENT

electrically. It was found that the arrangement is capable of detecting a change of temperature of the order of one sixteen-thousandth part of a deg. cent., and it was observed that while the heating current was flowing the note emitted by the telephone changed very smoothly, showing that no discontinuity in expansion could be detected, even with an apparatus capable of measuring one two-hundredth of a millionth part of an inch.

It may be mentioned in this connection that the possibility of applying the ultra-micrometer to the investigation of the relation between temperature and expansion of metals for very small increments of the former was pointed out in an editorial in *Mechanical Engineering*, Jan., 1921, p. 59, commenting on Professor Whiddington's ultra-micrometer. (*The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, vol. 43 (6th series) no. 253, Jan., 1922, pp. 223–226, 2 figs., *et*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

By introducing heat rapidly into the coal, and thus bringing about an immediate decomposition of the hydrocarbons in the cold coal, a concern at Granite City, Ill., succeeded in producing metallurgical coke from 100 per cent Illinois coal, hitherto considered as non-coking. The new product has been tried in the laboratory and in the blast furnace, and is said to have given excellent results. For further information see Making Coke from Illinois Coal, by M. W. Ditto, *Iron Trade Review*, March 9, 1922 (vol. 70, no. 10).

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Below are given the interpretations of the Committee in Cases Nos. 355, 375 (reopened), 377 to 383 inclusive, as formulated at the meeting of January 19, 1922, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

CASE NO. 355

Inquiry: An interpretation is requested of the application of the formulas in the Boiler Code for crown bars to a form of reinforcement for crown sheets where the top sheet of the fire box is a half of a true circle and is braced with arch bars extending over the top and down below the top row of staybolts at the sides, these arch bars being riveted to the water side of the crown sheet through thimbles. Recommendations of the Boiler Code Committee are requested covering low pressure steam heating boilers, as well as high pressure boilers.

Reply: This construction is not covered by the Code, but when the unstayed portion of the crown sheet does not exceed 120 deg. in arc, it is recommended that the maximum allowable working pressure should be determined by adding to the maximum allowable working pressure for a plain circular furnace of the same thickness, diameter and length by the formula in Par. 239, the pressure P_1 determined from the following formula, which is a modification of that in Par. 241, section *a*:

$$P_1 = 10{,}000{,}000\ \frac{b \times d^3}{p \times D^3}$$

where

b = width of crown bar, in.
d = depth of crown bar, in.
p = longitudinal pitch of crown bar, in.
D = outside diameter of furnace, in.

providing that the maximum allowable working pressure must not exceed that determined by the formula for furnaces of the Adamson type, in Par. 242 when L is made equal to p, and also providing that the diameter of the holes for the staybolts in the crown bars does not exceed $\frac{1}{3}\ b$, and the cross-sectional area of the crown bars is not less than 4 sq. in. Par. 199 would govern the spacing of the staybolts, rivets or bolts attaching the sheet to the bars.

CASE NO. 375 (REOPENED)

Inquiry: Is it permissible, under the requirements of the Boiler Code, to weld a seam in a vertical fire box not over 38 in. in diameter and in length ranging from 20 in. up, by the autogenous or fusion process where the fire box has no support other than the tube sheet, mud ring and fire door?

Reply: It is the opinion of the Committee that, under the requirements of the Code, autogenous or fusion welding is not permissible for the seam in the firebox of a vertical-tubular boiler, unless the sheet containing the seam is properly supported by staybolting or other form of construction.

CASE NO. 377

Inquiry: An opinion is requested from the Boiler Code Committee concerning the applicability of Par. 428 of the Code relative to the composition of the tin filling for fusible plugs, if used, where the boiler is to be operated under a working pressure of from 350 to 500 lb. per sq. in., so that the temperature of the steam under working conditions will be far above that specified for the melting point of tin.

Reply: There is nothing in the Code pertaining to the use of fusible plugs on boilers operated at pressures involving temperatures near or above the melting point of tin. It is accordingly proposed to revise Par. 428 by the addition of the following:

> Where the boilers are to be operated at working pressures in excess of 225 lb. per sq. in. gage, the use of fusible plugs is not advisable.

CASE NO. 378

Inquiry: If an internal boiler feed pipe enters at full size into a steam and water drum and then into a closed vessel within the drum, wherein the end of said feed pipe is open and the said closed vessel has a series of openings, accessible for inspection and the combined areas of which openings are largely in excess of the open end of the pipe, and means are provided for blowing down the interior closed vessel, does the construction meet the requirements of Par. 314 of the Code?

Reply: If the closed vessel within the drum, into which the open end of the feed pipe projects, has openings largely in excess of the area of the open end of the pipe so that there may be no possibility for them to become clogged by incrustation and providing the vessel has means for blowing down in cleaning, it is the opinion of the Committee that the construction described will meet the requirements of Par. 314.

CASE NO. 379

Inquiry: Would it meet the requirements of the A.S.M.E. Boiler Code for an authorized inspector to stamp a boiler as a 200 lb. pressure boiler if the same meets all the requirements regarding the boiler proper but the cross connection between the drums is composed of extra-heavy pipe and extra heavy flanged cast iron fittings?

Reply: It is the opinion of the Committee that a boiler so fitted with the cross connection using extra-heavy cast-iron fittings would not meet the requirements of Par. 9 of the Code.

CASE NO. 380

Inquiry: Is it necessary, under the requirement of Par. 336*b* of the Boiler Code, that a boiler head must be stamped by the manufacturer in two places when it is less than 12 in. in diameter and, due to the tube spacing, it is impossible to find room for more than one stamping?

Reply: It is the opinion of the Committee that as long as there is one stamp legible on a miniature boiler, the intent of the Code is met, where the parts are so small that it is impossible to apply two stamps.

CASE NO. 381

Inquiry: An interpretation is requested of the requirement in the last sentence of Par. 257 that calking shall be done with a round-nosed tool, where a form of flat-faced tool of the full width of the plate is being successfully used so as to thicken out or upset the end of the plate with pressure, instead of hammering. It is pointed out that with this method there is no danger of scoring or damaging the plate underneath the calking edge and the result is a very firm and effective result in calking.

Reply: It was the intent of the Committee in imposing this requirement that calking should be done so that the plate at or beneath the calking edge will not be scored or damaged. If the tool is of such shape as to upset or compress the edge of the plate without splitting it and will not score or damage the adjacent plate, the requirements of this paragraph may be considered as fully met.

CASE NO. 382

Inquiry: Is it not permissible, under the requirements of Par. 180 of the Code, to use plate thicknesses for the shells and tube

sheets of h.r.t. boilers thinner than those specified in Pars. 18 and 20, provided the maximum allowable working pressure formula gives the desired pressure with a factor of safety of 5?

Reply: It is the opinion of the Committee that it is not permissible under the rules of the Code, to use plate thicknesses in any case for shells or tube sheets less than the minimum thicknesses specified in Pars. 18 and 20 of the Code.

CASE NO. 383

Inquiry: Par. L-18 states in the first sentence that the gage thickness of the tubes shall not be less than a certain amount. In the second sentence it states that the gage thickness shall be measured by the B. W. gage and the thickness at any section must not vary more than one gage below or one gage above that specified. Does this require using one gage heavier than the nominal gage in order to meet the requirements?

Reply: The intent of the Committee in formulating this rule was that the gage thickness referred to in the first paragraph of L-18 of the Locomotive Code, described a nominal gage to be used. The gage thickness referred to in the second paragraph specifies that whichever gage is used, the limitations are minus one gage and plus one gage. Therefore, if a particular gage is specified for the boiler tube, the limits in gaging are one gage less and one gage more than that specified.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—RESEARCH RESULTS

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a resume of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Cement and other Building Materials A3-22. EFFECT OF MOISTURE CONTENT UPON THE EXPANSION AND CONTRACTION OF PLAIN AND REINFORCED CONCRETE. While the properties of concrete have been investigated for many years, attention has largely been given to considerations of strength alone. Studies of the less important properties, however, are also needed to explain phenomena that are observed in reinforced concrete structures, and to give information on questions relating to the appearance and durability of the material.

Aside from the action of direct load, deformations are produced in concrete by changes in temperature and in moisture content. With reference to temperature changes in reinforced concrete, it is well known that, regardless of differences in the mixture, concrete has practically the same coefficient of expansion as steel, so that the two materials contract or expand together. Moisture content, on the other hand, has the undesirable property of affecting concrete alone. Concrete, like wood, clay, and some other materials, expands when it absorbs moisture and contracts when it is dried; steel has no such action. After the concrete is poured the steel remains unchanged with changes in moisture conditions, while concrete ordinarily shrinks a considerable amount. Aside from the stresses set up in steel and concrete by the shrinkage of the latter, the resulting formation of cracks large or small will produce a condition which may be favorable to the corrosion of the steel or the disintegration of the concrete after repeated changes from dry to wet condition.

The tests which are described were made to investigate the amount of shrinkage which may be expected in a mortar or a concrete, the relation between the change of moisture content and the change of length of these materials, the difference in shrinkage of plain and reinforced concrete, and the interial stresses set up in the latter. For purposes of comparison with the results obtained with concrete, a few tests were made on the effect of the absorption of water by sandstone and limestone.

The paper contains numerous plots which present clearly to the eye the data obtained. It also contains a theoretical discussion of Shrinkage Stresses in Reinforced Concrete and closes with the following comments in the form of conclusions.

1 Concrete expands when it absorbs moisture and contracts when it is dried. Concrete of a 1:2:4 mixture is likely to contract during hardening as much as 0.05 per cent in an ordinary structure.

2 Contraction of concrete by the loss of moisture causes stress in the concrete when it is restrained by an external force. The amount of this stress is not as small as is generally supposed.

3 The shrinkage stress caused in the steel in reinforced concrete may reach the usually accepted working stress of steel when the amount of reinforcement is less than 1.5 per cent.

4 The shrinkage stress developed in 1:2:4 concrete may reach the ultimate tensile strength of the concrete when the amount of reinforcement is greater than 1.5 per cent. With richer mixtures the increase in shrinkage stress may be relatively greater than the increase in ultimate strength.

5 The greater the percentage of reinforcement the greater the tensile stress that may develop in the concrete, and concrete having a higher percentage of reinforcement than 1.5 per cent is likely to have cracks formed unless proper provision is made.

6 In reinforced concrete out of doors, subject to alternate wet and dry conditions, cracks may readily be formed under the repeated stress which is nearly equal to the tensile strength of the concrete.

7 Reinforced concrete does not appear likely to be a durable material in a place where a corrosive influence on steel such as sea air is active, unless proper protection against the formation of shrinkage cracks is made.

8 It is suggested that the prevention of shrinkage stress in concrete might be accomplished in two ways, either by finding a cement giving less expansion and contraction, or by the use of a perfect water-proofing treatment.

9 It may be expected that an integral waterproofing compound might lessen the change of volume for a short time, but it would not prevent the final diffusion of moisture with consequent change in volume.

This paper is issued as Bulletin No. 126 of the Engineering Experiment Station of the University of Illinios, Urbana, Illinios. Price, 25 cents.

Fatty Oils, Fats and Soaps, A1-22. CUTTING FLUIDS. See *Machine Tools A1-22.*

Heat A3-22. THERMAL EXPANSION OF NICKEL, MONEL METAL, STELLITE, STAINLESS STEEL AND ALUMINUM. The increasing use of nickel, monel metal, stellite, stainless steel, and aluminum for spark plugs, steam valves, automobiles, and in household and surgical appliances has created a considerable demand for the accurate determination of the thermal expansion of these metals and alloys.

Scientific Paper No. 426 of the Bureau of Standards, which will soon be for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents per copy, considers this subject fully. Ten samples of commercial nickel containing from 94 to 99 per cent nickel, 5 of which were heat rolled and 5 heat rolled and annealed, 10 samples of monel metal, 60 to 69 per cent nickel, of which 2 samples were cast, 3 hot rolled, and the remaining of various compositions and treatments, 5 samples of stellite of different grades, 2 samples of stainless steel, and 2 samples of 99.4 per cent aluminum were used in the work. The conclusions should prove of assistance to engineers using these metals in connection with varying temperatures.

Machine Tools A1-22. CUTTING FLUIDS. Technologic Paper No. 204 of the Bureau of Standards is divided into two parts, theory and practice. In the first part, the difficulties attending the proper lubrication of the cutting tool in machine work are described, and the reasons why lard oil is particularly suitable for this work are set forth. It is shown that the viscosity of an oil is not the only factor to be considered in this connection. Oils for cutting purposes should have a high adhesion, and it seems possible to improve mineral oils by adding such fluids as oleic acid, pine oil, and fixed oil.

An important function of cutting fluids is to cool the tool and chip, and for this purpose alone water with its high specific heat is well suited but it rusts the machines, and for this reason where water is used such alkaline substances as soda or soap are always added. In conclusion, part 1 suggests methods for the measurement of the adhesion of oils.

Part 2, practice, considers the correspondence which the Bureau conducted with many large machine shops throughout the country as to their experience with cutting fluids. The different kinds of oil which have been used for this purpose are listed, and attention is given to the possibility of using emulsions made up of mineral oil compounded with neutralized sulfonated oil and formed into a permanent emulsion with water.

Mineral oils compounded with alcoholic solutions of soap and a thick soap solution and mineral oil, marketed as a paste, are also described. In choosing any cutting fluid, it is pointed out that the character of the metal to be worked should be considered. Brittle metals, such as cast iron, are easier to lubricate than the so-called

"draggy" metals, such as soft steel and wrought iron. This Paper may be obtained at 15 cents a copy by addressing the Superintendent of Documents, Government Printing Office, Washington, D. C.

Paints, Varnishes and Resins A3-22. PRESERVATION OF MINE TIMBER. One of the recently issued Reports of Investigations of the Bureau of Mines is devoted to a study of the Growing Need for Preservation of Mine Timber. This report is written by Mr. R. R. Hornor a mining engineer of the Bureau. After demonstrating the large quantity of timber used in Mines the author discusses the decrease in the supply and quality of timber and the consequent need for general timber conservation.

The average life of untreated wooden surface structures is placed at 10 to 12 years; however, the average life of timber entering into mine and mill equipment subjected to replacement from decay is probably not over 6 to 8 years. Assuming the average period of usefulness of all kinds of mine construction is 20 years, then the timber subjected to decay will require replacement at least once during its period of service, in the case of surface structures, and twice in case of mine and mill equipment.

With proper preservative treatment of the original timber entering into this construction, it could be made to last throughout the entire period of service, thus effecting an important saving in the cost of material and labor.

To determine the advisability and economy of treating underground timber, also timber used in surface structures and equipment Barth formulated a rule which is substantially as follows: Timber that is permanent in character; that is which is not exposed to destruction by mechanical wear or crushing before the expiration of its natural life, or the usefulness of which does not cease before the advantages of chemical preservation can be realized, should be treated. Bureau of Mines, Washington, D. C., address H. Foster Bain, Director.

Petroleum, Asphalt, and Wood Products A3-22. PRESERVATION OF MINE TIMBER. See *Paints, Varnishes and Resins A3-22.*

Railroad Rolling Stock and Accessories A1-22. THERMAL STRESSES IN STEEL CAR WHEELS. See *Heat A2-22.*

Safety Devices A2-22. SURVEY OF ELEVATOR INTERLOCKS IN U. S. Technologic Paper No. 202 of the Bureau of Standards prepared by C. E. Oakes and J. A. Dickinson is entitled Results of a Survey of Elevator Interlocks and an Analysis of Elevator Accident Statistics.

This report gives the results of a field survey of several thousand elevator landings equipped with various types of mechanical and electromechanical interlocks and contact devices. The survey was conducted in connection with the preparation of an elevator safety code, in which work the Bureau of Standards engineers have coöperated with engineers of The American Society of Mechanical Engineers. The elevators are classified as follows: A, elevators in buildings having heavy service and where maintenance service is provided; B, elevators located in buildings where the service is heavy but without maintenance; and C, elevators on which the service is light and for which no maintenance service is provided. The statistics show that 73.8 per cent of all fatal accidents might be prevented by well-designed interlocks. Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents.

Steel Its Treatment and Products A3-22. TENSILE PROPERTIES OF SOME STRUCTURAL ALLOY AT HIGH TEMPERATURES. An investigation of this subject has been recently made by the Bureau of Standards and the results have been published as Technologic Paper No. 205. In this Paper the results are given of a number of determinations of tensile strength, proportional limit, elongation, reduction of area, and strength at fracture throughout the range 20 to 500 deg. cent. for 4 steels containing about 0.38 per cent carbon as follows: (*a*) Plain carbon steel; (*b*) 3½ per cent nickel steel; (*c*) 3 per cent nickel and 1 per cent chromium steel, and (*d*) 1 per cent chromium 0.2 per cent vanadium steel.

Brief reference is made to the types of fractures made in testing steels at various temperatures, and particular attention is paid to comparison of the tensile properties of these alloys at 550 deg. cent. Of the 4 steels tested in normalized condition, it appears that the two alloys containing chromium show greater resistance to weakening by increase in temperature to about 550 deg. cent. than either the plain carbon or 3½ per cent nickel steels, and at this high temperature the chromium vanadium steel is to be preferred from the standpoint of high tensile strength and limit of proportionality. The carbon and 3½ per cent nickel steels behaved alike with rise in temperature above that of the room and at about 550 deg. cent. the addition of 3½ per cent nickel appears to have but little effect upon the strength of the carbon steel. For copies of this Paper address the Superintendent of Documents Government Printing Office, Washington, D. C., 5 cents a copy.

Steel, Its Treatment and Products A1-22. GAS CYLINDERS. See *Gases, General A1-22.*

Transportation A1-22. SURVEY OF ELEVATOR INTERLOCKS IN U. S. See *Safety Devices A2-22.*

Welding A1-22. OXYACETYLENE WELDING AND CUTTING BLOW-PIPES. A very thorough investigation of oxyacetylene welding and cutting blowpipes was conducted by the Bureau of Standards at the request of the War Department. In this investigation special reference was given to their economy in operation, safety and design. Apparatus from 14 different manufacturers was submitted to test, and the character of the test was only decided upon after a thorough study had been made of the various operations in which these blowpipes are used.

The tests to which all the blowpipes were submitted were developed with the idea of minimizing the personal equation of the operator and securing data which were representative only of the blowpipe itself. In order to accomplish this result, a rather elaborate testing equipment, consisting of a weighing system, gage board equipment, welding table, cutting table, and safety flashback testing apparatus was designed and used throughout the investigation.

The paper describes in detail these various parts of the equipment and then considers the different classes of tests which were used for the cutting and for the welding blowpipes. The conclusions arrived at as a result of this work should prove of considerable assistance in improving the design of apparatus of this kind, with the object of securing better work, greater economy, and increased safety to the operator.

This investigation is fully described in Technologic Paper No. 200 of the Bureau of Standards, for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at 35 cents a copy.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for cooperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Heat Transmission B1-22. HEAT TRANSMISSION THROUGH INSULATION OF DYNAMO-ELECTRIC MACHINERY. A study of heat transmission through insulation, the dissipation of heat from surfaces, and the problems relating to air flow which are involved in the construction of dynamo-electric machinery is being made by the Research Department of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. Address Mr. C. E. Skinner, Manager.

Highways B2-22. TRACTIVE RESISTANCE OF CONCRETE ROADS. See *Transportation B2-22.*

Oils B1-22. PHYSICAL AND CHEMICAL CHARACTERISTICS OF OILS USED IN METER BEARINGS is one of the problems which are receiving attention of the Research Department of the Sangamo Electric Co., Springfield, Illinois. Address Mr. F. C. Holk, Chief Engineer.

Paints, Varnishes and Resins B2-22. The properties of Paints and Varnishes as well as those of all insulating materials employed in the construction of electric machinery are being investigated by the Research Department of the Sangamo Electric Co., Springfield, Illinois. Address Mr. F. C. Holk, Chief Engineer.

Transportation B2-22. TRACTIVE RESISTANCE OF CONCRETE ROADS. The tractive resistance of Concrete roads to motor vehicles is now under investigation. In the tests 1½ and 3-ton Army trucks and trailer and 7.5 ton Mack are used at variable loads and speeds with varied tire equipment, including measurement of vibrations in road material. Tire losses and internal vehicle losses are being determined in the Mason Laboratory, Yale University; the road tests are made conducted in both Connecticut and Massachusetts under Sub-Committee on Tractive Resistance of Roads, representing the War Department, Bureau of Public Roads, Highway Commissions of Conn. and Mass. Institute of Technology, Harvard University, Yale University, Society of Automotive Engineers, and National Research Council Committee on Economic Theory of Highway Improvement. Address: Major Mark L. Ireland, Q. M. C., U. S. A., Director, Room 10-219, Massachusetts Institute of Technology, Cambridge, 39, Mass.

F—BIBLIOGRAPHIES

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Mining F1-22. SUBJECT LIST OF REPORTS OF INVESTIGATIONS. Serial No. 2316 of the Reports of Investigations issued monthly by the Bureau of Mines. This list covers all reports issued up to December 31, 1921. Address Bureau of Mines, Washington, D. C., Mr. H. Foster Bain, Director.

Petroleum, Asphalt and Wood Products F2-22. PETROLEUM AND ALLIED SUBSTANCES. Reports of Investigations of the Bureau of Mines Serial No. 2317. This is a continuation of the bibliography reported in the March issue as Serial No. 2305. Address Bureau of Mines, Washington, D. C., Mr. H. Foster Bain, Director.

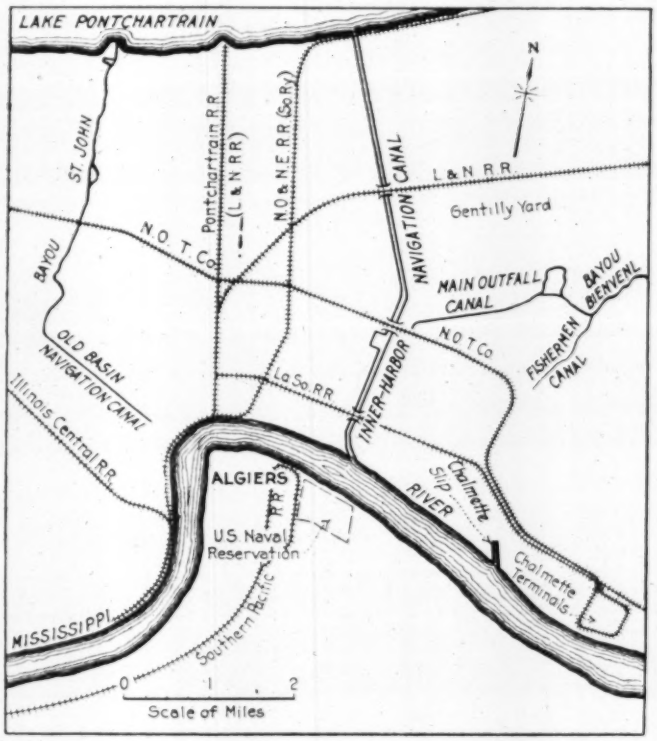
Windmills F1-22. WINDMILLS. A bibliography of two pages. Search 3519.

NEW ORLEANS NAVIGATION CANAL NEARS COMPLETION

One of the interesting port development projects on foot in this country is the so-called Inner-Harbor Navigation Canal which will soon be completed by the City of New Orleans at a cost of upwards of $20,000,000. This new channel is expected by its supporters to be the means of greatly increasing the standing of New Orleans among the ports of the world.

The city has been handicapped in its port development by the fact that the water frontage is all publicly owned, and it has been impossible for industries to function as they do where they can own and develop their water fronts as they see fit. In recent years the Dock Board has done what it could to improve conditions, but it was not within its power to be of any benefit to industries that wanted to buy. With the opening of the new canal however, it will be possible to develop a large privately owned water frontage, which, if properly planned, should take care of the utmost requirements for many years.

So far the plans provide for the opening up of eleven miles of new water front at practically constant water level, on which long term leases will be allowed. This frontage can be indefinitely



NEW ORLEANS INNER-HARBOR NAVIGATION CANAL

extended by lateral dredging and that part of the development has been suggested for private ownership.

The Inner-Harbor Navigation Canal is nearly five and a half miles long and extends from the Mississippi River across the city to Lake Pontchartrain. The Inner Harbor proper starts near the river at the lock and will be at the level of the Gulf of Mexico and subject only to its tidal fluctuations. It is dredged to a depth of 30 ft. below Gulf level over a section 150 ft. wide and is 300 ft. across at the surface. A depth of from 9 to 14 ft. already exists from the Lake Pontchartrain end of the canal out to the Gulf through Mississippi Sound. Eventually this could be dredged to a depth of 30 ft., which would give deep sea-going vessels a route into New Orleans some fifty miles shorter than by the river.

The Inner Harbor will be paralleled throughout its length on both sides by the Public Belt Railroad which connects with nine railroad trunk lines and is municipally owned and operated.

The lock that is being constructed to provide for passage of vessels from the outer harbor on the Mississippi into the Inner Harbor, is sufficiently large to accommodate ships of approximately 20,000 tons. This structure contains some 90,000 cu. yd. of reinforced concrete on 24,000 sixty ft. piling. It is 1050 ft. long and has a usable length of 640 ft., a clear width of 75 ft. and a depth at low water of 30 ft. It is equipped with four sets of miter gates 55 ft. high and another set 42 ft., each gate being operated by a 52-hp. electric motor. Also there is an emergency dam consisting of eight girders 80 ft. long, 3 ft. wide and 6 ft. high which weigh about 90 tons each and which can be operated in recesses in the lock walls by an emergency dam girder bridge operated by a 300-hp. motor. The location is about 2000 ft. inside the main river levers and the channel connecting is 125 ft. at the bottom by 300 at the surface by 30 ft. deep at low water.

The Canal is crossed by four double track railroad bridges of the Strauss-Bascule type, having a clear span of 117 ft. and each bridge is provided with a 20-ft. driveway on each side.

It is expected that an immediate result of the completion of this development will be the bringing into the Mississippi River by barge, and making available to ships there, great quantities of lumber, coal, iron and other products from Louisiana, Mississippi and Alabama. (Prepared from material submitted by Walter B. Moses, Correspondent to MECHANICAL ENGINEERING from New Orleans.)

Government and Industry Coöperate in Standardization

At the request of Secretary Hoover, the American Engineering Standards Committee has designated Mr. A. A. Stevenson, the retiring Chairman of the Committee, as a special representative to work with the Department of Commerce in bringing about closer and more effective coöperation between the Department's Division of Simplified Practice and the A.E.S.C.

It is the function of the Division of Simplified Practice to stimulate simplification in industry to decrease the cost of production and distribution of manufactured articles through the elimination of varieties and sizes. The work of the Division, which was organized in 1921 and is under the direction of Mr. W. A. Durgin, formerly of the Commonwealth Edison Company, Chicago, is actively under way. The A.E.S.C. has offered Secretary Hoover the use of its machinery in carrying technical projects initiated in the simplification program of the Department of Commerce. As a result of this offer Mr. Stevenson was designated as representative.

Mr. Stevenson, who is a Past President of the American Society for Testing Materials and has had a most extensive experience in standardization work, is Vice President in charge of manufacture, of the Standard Steel Works Company, which is a subsidiary of the Baldwin Locomotive Works.

Annual Meeting of Engineering Foundation Board

The Seventh Annual Meeting of the Engineering Foundation Board was held at the Engineering Societies Building in New York on February 9, 1922. The Board voted to print the Annual Report of the Engineering Foundation and the abridged report on Fatigue of Metals. Progress reports were presented on the research work of the American Bureau of Welding and on the investigation of the Properties of Steam to which the Engineering Foundation is contributing.

The Board consists of four trustees of the United Engineering Society, Messrs. George H. Pegram, Edwin Ludlow, George M. Basford and Bancroft Gherardi; eight members nominated by the governing bodies of the Founder Societies, A.S.C.E., Messrs. Edward Dean Adams and Silas H. Woodward; A.I.M.E., Messrs. Arthur L. Walker and Herbert M. Boylston; A.S.M.E., Messrs. John H. Barr and D. S. Jacobus; A.I.E.E., Messrs. F. B. Jewett and E. Wilbur Rice, Jr., three members at large, Messrs. Elmer A. Sperry, Charles F. Rand, H. Hobart Porter, and Mr. J. V. Davies, ex-officio, President U.E.S.

The following officers were elected to serve until the Annual Meeting in February, 1923: Charles F. Rand, Chairman, Edward Dean Adams, first vice-chairman, Frank B. Jewett, second vice-chairman, Joseph Struthers, treasurer, Henry A. Lardner, assistant treasurer, Alfred Flinn, secretary, Vernon Kellogg, assistant secretary, and George H. Pegram and H. Hobart Porter additional members of the Executive Committee.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

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Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

The Engineering Resources and Possibilities of Muscle Shoals

"More foolish things have been said about Muscle Shoals, pro and con, than about any other matter I ever investigated," was the gist of a remark made recently by a prominent witness before the House Military Committee in response to an inquiry about some rumor or other. It is true that, in the mass of discussion spoken and published, there has been so much misstatement and exaggeration and so much picturesque and imaginative prediction that there is difficulty in visualizing the actual physical situation and in appraising its reasonable possibilities.

J. W. JOYES

The subject is large and intricate, and such a brief statement as can here be presented must be but a bare outline. It will be uncolored by prejudice and as accurate as is possible.

The term "Muscle Shoals" has been used loosely to embrace all the actualities and all the dreams that center about the Muscle Shoals section of the Tennessee River, extending some thirty-five miles upstream from the cities of Florence and Sheffield, Ala. In this thirty-five miles the river has a fall of some 130 feet, so that power-development possibilities offer advantages offsetting the navigation disadvantages but there has been much propaganda in the adjacent states for both the navigation improvement and the power development.

Importation from Chile of sodium nitrate to make nitric acid for military explosives was precarious. Therefore the Chief of Ordnance, U. S. Army, called attention to the desirability of establishing nitrogen fixation plants and advocated making such plants support themselves in peace-time by producing fertilizer material.

The chance to realize the Southern "cheap fertilizer" ideal by giving such plants cheap power, while at the same time achieving the long-desired power development and navigation improvement of the Tennessee River, led to the linking together of the nitrate plant and the Muscle Shoals propaganda, and to the inclusion in the National Defense Act of 1916 of the Section 124, which appropriated $20,000,000.00 for "Nitrate Supply."

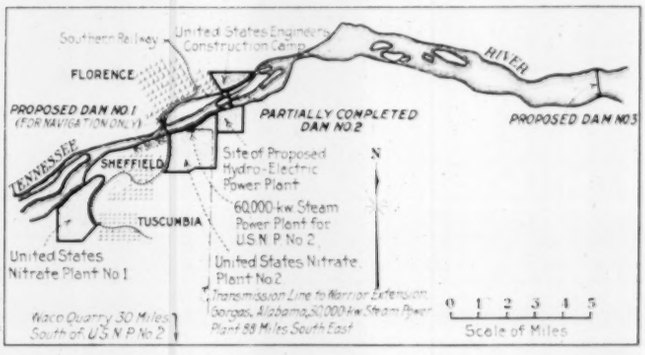
Under that law and upon the advice of a committee of prominent scientific, technical and business men, it was decided first to build a plant to make ammonia by synthesis of gaseous nitrogen and hydrogen, using a process then in a promising state of development and similar to the Haber-Bosch process then known to be successfully operated in Germany. This plant is U. S. Nitrate Plant No. 1, just southwest of Sheffield, Ala. It produced very little ammonia, due to not achieving continuous operation and the changes shown by deliberate study since 1918 to be necessary to assure efficient operation have not been made. This plant is therefore not a "going" plant and its water-gas installation, gasometers, 1500 lb. per sq. in. gas compressors, heat interchangers, reaction vessels, etc., are carried at salvage value only. There are, however, useful industrial buildings, and auxiliary plant apparatus of some value. The 1900 acres of land, 100 or so dwellings, roads, railroad, water and sewer lines, etc., will have value dependent upon the general vicinity development—small at present.

Urgent need for large quantities of explosive for munitions during the War, and other considerations combined to induce the building of the great U. S. Nitrate Plant No. 2 to make the explosive ammonium nitrate without either nitrate or ammonia from any extraneous source.

The flow sheet of this plant is briefly:

a Limestone crushed and lump coke

b Lime (in 7 kilns) and coke (crushed and dried) in


Southern Railway
United States Engineers Construction Camp
FLORENCE
RIVER
PROPOSED DAM NO 1
(FOR NAVIGATION ONLY)
PARTIALLY COMPLETED DAM NO 2
PROPOSED DAM NO 3
TENNESSEE
SHEFFIELD
Site of Proposed Hydro-Electric Power Plant
60,000 kw Steam Power Plant for U.S.N.P. No 2
N
TUSCUMBIA
United States Nitrate Plant No 1
United States Nitrate Plant No 2
Transmission Line to Warrior Extension
Gorgas, Alabama, 30,000 Kw. Steam Power Plant 88 Miles South East
Waco Quarry 30 Miles South of U.S.N.P. No 2
0 1 2 3 4 5
Scale of Miles

MAP SHOWING LOCATION OF PARTS OF MUSCLE SHOALS DEVELOPMENT

Twelve electric furnaces, giving calcium carbide

d Carbide, plus nitrogen (from liquid air plant) give, in 1536 ovens

e Lime-nitrogen, which when crushed and ground and treated with steam in 56 autoclaves, gives

166 tons gaseous ammonia per day

g 90 tons of ammonia oxidized in 696 catalyzers, gases giving, in 48 towers (21 × 31 × 34 ft.), dilute nitric acid (equivalent 280 tons HNO_3)

h Remainder of ammonia and the acid react in neutralizers to ammonium nitrate solution, which then concentrated and evaporated in 5 buildings give

i End product 300 tons per day, 110,000 per year, crystallized ammonium nitrate.

The rectangle embracing those processes is 5310 by 2860 ft. The seven lime kilns are 125 ft. long. The twelve electric furnaces are each 22 × 13 × 6 ft. inside have three electrodes 16 × 48 × 80 in. and use 8300 kva. The liquid air plant is the largest in the world—30 Claude units. There are twenty-nine acres of actual process buildings of standard concrete and steel-mill type.

For rated production some 90,000 horsepower is required.

As half production was needed six months after breaking ground a 110,000-volt, 33,333 kva. transmission line had to be built and contract made for part of the power requirement from an established power system. To insure continuity of this supply the United States had to build the "Warrior Extension"—a 30,000 kw. addition to the power company's steam station at Gorgas.

For the remaining power requirement, a steam power station was built at U. S. Nitrate Plant No. 2 on the river bank. This has twelve B. & W. Stirling boilers of 1507 nominal boiler horsepower, a 60,000 kw. Westinghouse Parsons double flow cross-compound

turbine in three elements and three 23,000 kva., 12,200 volt, 3-phase, 60 cycle Westinghouse generators, with surface condensers and complete accessories throughout. Fuel is dumped into overhead hoppers from standard railroad cars on a track over the power-house roof at about the level of the ground adjoining the gully in which the power house is located. Ample space is left in the generator room for an additional turbo-generator of 30,000 kw. or greater capacity. This plant has high efficiency and will have large value as a steam stand-by when the water power is developed and at small cost can transform 80,000 horsepower from secondary to primary power.

Nitrate Plant No. 2 has one other accessory, the limestone quarry owned in fee at Waco, 30 miles south of the plant proper. Here there is a supply of stone for probably 50 or more years. The bed is flat, with shallow overburden, giving a pit quarry which has been opened and provided with a crushing plant for 2000 tons of stone per day, with power from the transmission line mentioned. Diamond drilling, etc., show a good 50 foot thickness with average composition up to specification, that is about 98 per cent calcium carbonate.

The U. S. N. P. No. 2 site of 2300 acres, which is owned in fee, is bounded by the river, the joint tracks of L & N and Southern railroads and by highways and has 188 good dwellings besides 263 negro houses, a 100-room administration quarters, etc. All are of value to a going plant. There is also an adequate water supply system with reservoir and filter, 20 miles of sewers, 22 miles of slag and chert roads, 37 miles of railroad, an ice plant, etc.

The process plant is most carefully designed with modern material-handling devices and each process showed, upon test, high efficiency and even more than rated production. It will be seen from the flow-sheet that there are opportunities to divert all or part of several of the intermediate products to a different final product. For instance, ammonia may be diverted to be made into sulphate and the calcium cyanamide might be sold without further processing than hydrating. Other possible end-products now obvious are ammonium phosphate, urea, calcium nitrate, nitroguanadine, veronal and many others, providing of course certain additions of special process-apparatus and additional raw materials called for were made.

The original end-product, ammonium nitrate, has excellent fertilizer value containing 35 per cent nitrogen as against 21 per cent in sulphate and 15 per cent in Chile nitrate; but it is an explosive and so deliquescent that it would be troublesome to handle. This may be treated to diminish its deliquescence but is still explosive. It may be combined with sulphate giving the double ammonia salt or it may be mixed with potassium chloride thus bringing in another valuable fertilizer ingredient, potash.

The ideal of the fertilizer research man is a crystalline substance, not deliquescent, containing in soluble form the three essentials, nitrogen, potash, phosphoric acid, and as little of any other substance as possible. With that, freight need be paid upon only the plant foods and not upon useless matter such as the present commercial fertilizer contains to the average extent of 85 per cent.

Research has already produced some most promising results. Of these, electric furnacing of phosphate rock offers prospect of being a more advantageous method of rendering phosphoric acid available than the present method.

It is correct to say that in such advanced methods to be developed by the laboratory and efficient technicians lies the main hope of this plant—for ammonium nitrate is objectionable, calcium cyanamide has objectionable features limiting its use, and sulphate can, even with water power costing less than one-tenth of a cent per kwh. hardly be produced at a cost to compete with by-product coke-oven sulphate or Chile nitrate.

A word as to quantity. Of the 8,000,000 tons or so of complete fertilizer used in this country in a year (speaking very generally) nitrogen makes up only 200,000 tons. The U. S. Nitrate Plant No. 2 product, 110,000 tons of ammonium-nitrate or equivalent, contains roughly 40,000 tons of nitrogen—about one-fifth of the aggregate.

Such are the properties of the United States at Muscle Shoals—other than the dam—and such are some of the possibilities that may with reason be now predicted for them. It remains to speak of the dam and its possibilities.

Dam No. 2 (the Wilson Dam) has about 30 per cent of the permanent structure done. It is to have a normal head of 95 feet and may probably be rated as capable of delivering about 100,000 hp. primary, 100,000 hp. secondary (10-month power) with some 150,000 hp. available for six months and even more for shorter periods. If the efficient steam plant at U. S. Nitrate Plant No. 2 (80,000 hp.) and the Warrior Extension steam plant (40,000 hp.) be used as stand-by power, a corresponding amount of secondary water power is of course converted at small cost into more valuable primary power. Dam No. 1, proposed, is for navigation only and to give no power. Dam No. 3, not commenced, is planned for about 40 ft. head and would add correspondingly to the primary and secondary power usable. The pools of these dams would no more than take care of daily fluctuation. The possibilities of steam regulation by up-river storage are large, but too indefinite to discuss here. Tie-lines to other systems offer other possibilities of increase of usable power and of course industries run by the owner of the power may use very short-period power that could hardly be sold.

It is safe to say that development of this power should bring in to the vicinity many electrometallurgical industries and many electrochemical industries other than nitrogenous fertilizer. The nearby iron ore, coal, limestone, phosphate, bauxite and other minerals speak for themselves. Ferromanganese and ferrosilicon are already in production in Alabama and Tennessee. Almost to a certainty much general manufacture would spring up and power not used locally may be distributed over a large area. J. W. JOYES.[1]

Mr. Prindle's Signal Service in Patent Relief

Every member of the engineering profession should recognize the able and painstaking contribution on their behalf by Mr. Edwin J. Prindle, who, as Chairman of the Patents Committee of American Engineering Council, and as a representative of The American Society of Mechanical Engineers on that Committee, was largely instrumental in securing the passage of the Lampert Bill, providing much needed relief and increasing the salaries and staff of the Patent Office.

"Throughout the long fight from the time that the project started as embodied in the Nolan Bill, during times thereafter when it seemed that everything was against progress, and until the Lampert Bill was signed by the President, Mr. Prindle spared no personal time or effort in advancing the movement. In this work he kept his committee with him, and made sure of every step, but his fellow members do not hesitate to concede that his efforts stand out far above those who had the honor of serving with him, and they gladly accord him all the credit."

This extract from a letter by Dr. D. S. Jacobus, a co-worker with Mr. Prindle on the Patents Committee is a fitting tribute to his energy and sacrifice in advancing this important work.

The history of the enactment of the bill is familiar to many since the political procedure necessitated public hearings before committees of the Houses, and the members of the profession had to be called upon frequently to make their influence felt at Washington and to back up the Committee in its efforts.

The fight for relief was started in 1917 when the National Research Council was requested by the Patent Office itself to appoint a committee to find out what could be done about relieving a situation of inability to obtain suitable men in the Patent Office in view of the insufficiency of salaries which had only been increased eight per cent since 1848. The recommendations of this Committee resulted in the formulating of the Nolan Bill H. R. 11,984, immediately approved unanimously by the Patents Committee of the House. Mr. Prindle was appointed to this committee as a representative of the A.S.M.E. and he served as secretary.

The work was brought closer to the Engineering Societies through the agency of Engineering Council which appointed a Committee to aid in the passage of the bill, and on this Committee Mr. Prindle's name also appeared. Mr. Charles A. Terry was Chairman but soon resigned, and Mr. Prindle took his place. Mr. Prindle was also made a member of the Patent Committee of the National Association of Manufacturers, and Chairman of the Patent Committee of the American Chemical Society, the latter honor being

[1] Colonel Ordnance Dept., U. S. Army, Washington, D. C.

a recognition of his ability to assume the leadership in this reform.

After a hearing organized by Mr. Prindle and attended by representatives of the sixty organizations supporting it, the Nolan Bill passed the House but in the Senate it became involved with a Federal Trade Commission amendment. This amendment prejudiced the bill and the Senate failed to pass it. Then came an adjournment of Congress and the work had practically to be started all over again with the new Congress. The first step was the elimination of the Federal Trade Commission Amendment which was successful. Re-introduced into the new House by Mr. Lampert, then Chairman of the Patent Committee, the bill took his name. Opposition now came from the floor leader who held that the increases recommended were too high and that it would interfere with a bill for the general re-classification of governmental service. This necessitated another campaign to bring the bill up for a vote, which was successful in spite of strenuous opposition. The tide had now turned and the introduction of the bill into the Senate resulted in its passage without a single negative vote. The bill became law on February 18, 1922 by the signature of President Harding.

In recognition by the Patent Office of his able and painstaking work, the Commissioner of Patents presented to Mr. Prindle the pen with which the President signed the bill.

The Bill adds $451,000 to the payroll of the Patent Office, and increases the salaries of the Examiners approximately 45 per cent, and the number of Examiners 10 per cent. The Bill also contains a patent law amendment, proposed by Mr. Prindle, which will make a money recovery possible in all patent infringement cases where the patent has been held to be valid and there has been any substantial use of the invention. Heretofore the rules governing accountings in patent infringement suits have been so technical and illiberal that a money recovery has been impossible in most cases. Recently a few decisions have been rendered in which a more equitable principle has been applied to a limited class of infringement cases. The amendment makes the said principle statutory and extends its application to all classes of infringement cases. The amendment has been approved in principle by a number of United States Judges, and no judge has disapproved of it. It is believed that it will greatly stimulate the production of inventions, which is the object of the patent system.

Richard H. Rice, Manager G. E. Lynn Works, Dies

Richard H. Rice, late manager of the Lynn Works of the General Electric Co., an outstanding member of the engineering profession and a leading authority on steam turbines, died on February 10, 1922, at Bolton on Lake George, N. Y. Mr. Rice was born on January 9, 1863, at Rockland, Me. He was educated in public schools and Stevens Institute of Technology from which he received his M.E. degree.

He served his apprenticeship with the Pittsburgh, Columbus, Cincinnati and St. Louis Railroad, then becoming a draftsman at the Bath Iron Works in Maine. His enthusiasm and ability as chief draftsman with E. D. Leavitt, Cambridge, Mass., brought him the position of general superintendent of the Wm. A. Harris Steam Engine Co., Providence, R. I. Later he was secretary-treasurer of the Rice Sargent Engine Co. and the Providence Engineering Works.

In 1903 he became associated with the General Electric Co. as engineer in the turbine department of their Lynn Works where he started work on the development of the turbine to its present extensive proportions. In 1918 he was made manager of the plant.

Mr. Rice combined the qualities of a skilled engineer and inventor with marked ability as an executive. He had a warmth of human sympathy, a regard for the feelings of others and a democratic spirit which made him a man easy of approach. He leaves as a monument to his memory the plan of representation in effect at the Lynn Works whereby his fellow employees reap the advantages of a new, yet very old idea—good will, friendship and coöperation.

Many business and professional organizations counted him as a member. He became a member of The American Society of Mechanical Engineers in 1890 and from 1904 to 1907 served as one of its managers. For the first two years of its existence he was president of the Associated Industries of Massachusetts; he was a past-president of the National Conference of State Manufacturers' Associations. He was also a member of the Providence Engineering Society and the American Institute of Electrical Engineers. He was a member of the Boston Chamber of Commerce, a director of the Lynn Chamber of Commerce, a member of the State Committee on Unemployment and during the War served as a member of the Lynn Fuel Commission. He was the author of several technical papers dealing with turbine engines and the inventor of some fifty patented devices for use of steam, air and water, chief among which was his design for the first turbo-blower for blast furnaces in America. In June of 1921 he was awarded degree of Doctor of Engineering by Stevens Institute.

U. E. S. Report for 1921

The report[1] of the treasurer of United Engineering Society for the calendar year 1921 shows a balancing account on December 31, 1921, of $26,434.31, as compared with a balancing account on December 31, 1920, of $16,954.72. The cash on hand as of December 31, 1921 amounted to $14,219.35. Following is a statement of the treasurer's receipts and payments for the year:

RECEIPTS

Cash on hand January 1, 1921		$15,029 02
From Founder and Associate Societies for offices storage halls, telephones and miscellaneous	$98,666 45	
From societies not in building for halls and miscellaneous	17,530 79	
For Library, General Maintenance and Operation	25,291 61	
For Library Service Bureau	16,738 16	
For Library Recataloguing	12,291 53	
Income collected on Investments and Deposits of U. E. S.	12,116 83	
Income collected on Engineering Foundation investments	24,533 57	
Sale of Securities	27,874 38	
From A. I. E. E. for Building Addition	2,500 00	237,543 3
		$252,572 34

PAYMENTS

To Engineering Foundation Income from Investments less Collection charges	$24,258 31	
For Securities purchased	25,400 00	
" Building Operating expenses	101,370 21	
" Library	27,588 43	
" Library Service Bureau	15,755 41	
" Library Recataloguing	13,606 01	
" A.S.M.E. Note	2,500 00	
" A.S.M.E. Interest on note	206 20	
Collection, custodial and Adv. charges and exchanges	650 83	
For Engineering Council	14,500 00	
" Engineering Soc. Service Bureau	406 74	
" Permanent Improvement charged to capital	1,786 36	
" Renewals in steam system charged to Depreciation and Renewal Fund	9,395 91	
For American Delegation Dinner	805 10	
" Miscellaneous	122 48	
Grand total		$238,352 99
Cash on hand December 31, 1921		14,219 35
		$252,572 34

The assets and liabilities as of December 31, 1921, were as follows:

ASSETS

Property		$1,959,140 67
Land	$540,000 00	
Building	1,361,969 51	
Equipment	33,171 16	
Founders' Preliminary Expenses	24,000 00	
Investments, Foundation		502,066 05
Library		93,351 25
Depreciation and Renewal		98,639 47
General Funds		10,000 00
Cash	10,477 25	
Special Cash Funds	50 00	
Due from Cleveland Trust Co.	99 16	

[1] Extracts from treasurer's report for 1921.

Cost of renewals paid from Operating Cash to be reimbursed from Depreciation and Renewal Fund Assets	1,698.47	
Accounts Receivable	8,835.98	
Accrued interest receivable on Library Endowment Investments	1,246.14	22,407.00
Deferred charges, prepaid insurance		4,230.31
		$2,689,834.75

LIABILITIES

Founders Equity in Property	$1,959,140.67
Engineering Foundation Reserve	502,066.25
Library Endowment Reserve	93,351.25
Depreciation and Renewal Reserve	98,639.47
General Reserve	10,000.00
Collection on account Osterberg Fund	91.50
Income from Engineering Foundation Investments collected and to be paid to Engineering Foundation Board	58.60
Deferred credit—unexpended balance in American Delegation Dinner Account	52.90
Balance December 31, 1921	26,434.31
	$2,689,834.75

NEWS OF OTHER SOCIETIES

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

The tenth annual Midwinter Convention of the American Institute of Electrical Engineers was held in New York, February 15 to 17, 1922. This function is traditionally devoted to the presentation and discussion of highly technical subjects.

President McClellan opened the first session Wednesday afternoon with a short address emphasizing the opportunities of the engineering profession in the readjustment and developing of the country at the present time. He considered the transportation problem one of the most important and suggested that electrification of railroads might be the solution. He also pointed out that with greater development of power sources, a trend which is already making itself felt, the age will be one where engineering genius of every type and especially along electrical lines will more than ever be in demand.

The papers were then presented: The Key West-Havana Submarine Telephone Cable System, by W. H. Martin, G. A. Anderegg and B. W. Kendall; Submarine Cable Telegraphy, by J. W. Milnor; and Printing Telegraph Systems Applied to Message Traffic Handling by A. H. Reiber.

In the evening the Questionnaire on Lightning Arresters, by F. L. Hunt was read and it was followed by Deviations from Standard Practice in Lightning Arresters, by E. E. F. Creighton, and Condenser Discharge through a General Gas Circuit by Charles P. Steinmetz.

On Thursday morning, after the meeting was opened by the President, E. B. Meyer, chairman of the Transportation and Distribution Committee presided. Papers were presented as follows: The Peterson Earth Coil, by R. N. Conwell and R. D. Evans; the Effect of Moisture on the Thermal Conductivity of Soils, by G. B. Shanklin; Five Hundred Tests on the Dielectric Strength of Oil, by J. L. R. Hayden and W. N. Eddy, and An Analytical Investigation of the Causes of Flashing of Synchronous Converters, by E. B. Shand.

H. R. Woodrow, Chairman of the Protective Devices Committee, occupied the chair in the afternoon and the following papers were read: The Use of Superimposed Imaginary E. M. Fs., Currents and Fluxes in the Solution of Alternating-Current Problems, by V. Karapetoff; Question on the Economic Value of the Overhead Grounded Wire by E. E. F. Creighton; Wave Form and Amplification of Corona Discharge by J. B. Whitehead and N. Mouye; Prevention of Transient Voltage in Windings, by J. Murray Weed.

On Thursday evening the Edison Medal was presented to Cummings C. Chesney which was followed by an address on Colloids by Dr. W. D. Bancroft.

Friday morning C. E. Skinner acted as chairman and the papers were: Heating of Railway Motors in Service and on Test Floor Runs, by G. E. Luke and The "Indumor," by V. Karapetoff.

The following papers were read by titles only: Skin Effect and Proximity Effect in Tubular Conductors, by Herbert Bristol Dwight, Heat Losses in Stranded Armature Conductors, by Waldo V. Lyon, Current Locus of Single-Phase Induction Motors, by J. K. Kostko, and Polyphase Commutator Machines, by A. B. Field.

Friday afternoon about 300 members registered for an inspection trip to various power plants and in the evening the usual dinner dance was held at the Hotel Astor, completing a most beneficial and enjoyable convention.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

The 125th meeting of the American Institute of Mining and Metallurgical Engineers was held in New York, Feb. 20–23, 1922. The total registration of 744 members and 587 guests was larger than in any previous year and it was considered the most successful convention ever held by the Institute.

At the annual business meeting three new officers, headed by Arthur S. Dwight, Director and President, and five new directors, were elected.

From Monday afternoon through Wednesday afternoon there were four simultaneous sessions being carried on both morning and afternoon. Of these the symposium on Foreign Oil Possibilities and Details of the Oil Industry aroused the greatest interest and attracted the largest attendance. The first two sessions were devoted to addresses by eighteen different men on Oil Reserves in the various countries and continents.

The Mining Sessions, also four in number, were well attended throughout, and 30 papers covering subjects from Sampling and Estimating Ore Deposits to General Outlines for Obtaining Data were read. The latter was in connection with the collecting of data from all the big mines of the United States for the benefit of those who contemplate making a choice in mining methods.

There were three Safety Sessions, joint meetings of the Mining Section of the National Safety Council and Industrial Relations Committee of the Institute. The first was on Wire Ropes and Hoisting, the second on Ventilation and the third dealt with miscellaneous features.

The Session on Industrial Relations included reports from subcommittees on Americanization all along the line to Mental Factors in Industry and Safety. A paper was also read on Preservation of Natural Scenery and Attractiveness of Mining Camps.

The Institute of Metals Division had two sessions in which nine papers were read and a lecture given by Prof. Wilder D. Bancroft on Colloid Chemistry and Metallurgy attracted a great deal of interest.

One of the two Iron and Steel Sessions was in memory of Prof. J. W. Richards who was for many years its very able and efficient chairman. Seven papers were read at the two meetings.

Other features were: A noteworthy joint meeting with the Mining and Metallurgical Society, considered by some a rival organization, and at which five papers on Waste in the Mining Industry were read; a Local Sections Convention, which was a most successful innovation; and entertainments. The latter included the annual smoker on Monday night at which J'Aime presented the Folies Minieres, a Review with Pangs; and the annual banquet and ball in the Grand Ball Room of the Pennsylvania Hotel. An informal dance, reception and excursions contributed toward making it the pleasantest as well as the most successful convention in the history of the Institute.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

The winter meeting of the American Boiler Manufacturers' Association was held at the Fort Pitt Hotel, Pittsburgh, Feb. 13, 1922, A. G. Pratt of the Babcock and Wilcox Company presiding. Secretary H. N. Covell reported the Association having 77 active and 20 associate member companies. For the Committee on Ethics, George B. Bach reported that no breach of the Association's Code had been reported in spite of strenuous competitive conditions during the preceding year.

A report from the committee appointed to determine how thoroughly the A.S.M.E. Code is being lived up to by members of the Association was presented by W. C. Connelly. To the question, "Are you complying with the A.S.M.E. Code, par. 14, 28, 36, 180 and interpretation no. 295?" fifty replied "Yes," one "No," and three "Not always." Other questions such as the advisability of having the Code Committee set a maximum thickness for shell plate and what that thickness should be, brought varying replies.

Of the 36 who answered the first part only ten opposed a maximum, but when it came to setting a figure the opinions varied from $^{7}/_{16}$ to $1^{1}/_{4}$ in. Seven favored $^{5}/_{8}$ and six suggested $^{9}/_{16}$ in. An inquiry as to the use of a single sheet for boiler bottoms brought forth a good deal of discussion, the concensus of opinion seeming to be that plates about an inch thick if of sufficient tensile strength are much better than heavier ones.

Mr. C. W. Gorton presented a paper on the National Board of Boiler and Pressure Vessel Inspectors and its relation to the Boiler Manufacturing Industry. Through a policy of One Code, One Stamp, One Inspection, this Board makes it possible to have a boiler accepted in any of a constantly growing number of states, if it is according to the A.S.M.E. Code.

An invitation was received from the American Society of Mechanical Engineers for the Association to appoint a representative on the Committee on Bolts, Nuts and Rivets.

Engineering Institute of Canada

The Engineering Institute of Canada held its annual meeting at the Montreal headquarters, January 24 and 25, 1922. The officiers elected for 1922 include, President, J. G. Sullivan, consulting engineer; and vice-presidents, Brigadier General C. B. Mitchell and Arthur Surveyer.

Three new branches were founded, one at Sydney, Nova Scotia, one at London, Ontario, and one at Lethbridge, Alberta. Among the most interesting technical papers were: An explanation of the design features of the latest hydroelectric development of the Shawinigan Water and Power Co., by Julian C. Smith, who is a vice-president and general-manager of the company; and an illustrated lecture by Major Draper on the construction of the new St. John cantilever bridge.

The entertainments included a visit to the Dominion Engineering Works at Rockfield, the annual banquet and a smoking concert.

LIBRARY NOTES AND BOOK REVIEWS

Airplane Engine Encyclopedia. By Glenn D. Angle. First edition. Otterbein Press, Dayton, Ohio, 1921. Cloth, 6×9 in., 547 pp., illus., diagrams, $7.50.

A reference book for those interested in airplane engines. Contains information concerning the design, sizes, construction and performance of the engines of about one hundred and seventy-five makers, arranged by names. Based on information from original sources and the leading books and periodicals. Includes every engine known to the author.

Architects' and Builders' Handbook. By Frank E. Kidder. Seventeenth edition. John Wiley & Sons, Inc., New York, 1921. Fabricoid, 4×7 in., 1907 pp., illus., tables, $7.

Two new chapters, on Specifications for the Steelwork of Buildings, and on Domical and Vaulted Structures, have been prepared for this edition. The chapters on Fireproofing of Buildings and on Reinforced-Concrete Construction and the sections on Heating and Ventilation and on Chimney Construction have been rewritten. In addition the whole text has been revised, numerous new articles inserted and a new index made. The total additions amount to 90 pages. The book is intended to contain information on every subject, except design, likely to come before an architect, structural engineer, draftsman or builder, and to be a thorough handbook of architectural engineering.

Automotive Repair. By J. C. Wright. Vol. 1. John Wiley & Sons, Inc., New York, 1921. Cloth, 6×9 in., 530 pp., illus., diagrams, $3.50.

This book is for the repairman or owner who is expected to make general repairs and keep a car fit for operation. One hundred and eighteen jobs are given, with complete instructions. These are divided into chassis, engine, electrical, body and radiator work and "trouble shooting," and cover, it is said, 95 per cent of all the problems which will confront the repairer. The second section of the book presents the theoretical and mechanical information required to understand the construction and operation of the automobile.

Burning Liquid Fuel. By William Newton Best. [Revised edition.] U. P. C. Book Co., Inc., New York, 1922. Cloth, 6×9 in., 341 pp., illus., diagrams, $4.

This revised and enlarged edition of Dr. Best's book, formerly entitled the Science of Burning Liquid Fuel, is a plain, straightforward summary of long practical experience in designing and erecting oil-fuel installations. Specific information is given upon the use of liquid fuel in many industries and upon all the various forms of equipment. Drawings show how the equipment is applied to various purposes. The book discusses, among other topics, locomotive, stationary, marine and low-pressure boiler equipment; practice in foundries and forge shops; and equipment suitable for the sugar, copper, ceramic, cement, baking, candy and oil industries.

Deep Well Drilling. By Walter H. Jeffery. W. H. Jeffery Co., Toledo Ohio, 1921. Cloth, 6×9 in., 531 pp., plates, illus., diagrams., tables, $5.

The author has undertaken to cover the two methods most generally used, the cable tool and the hydraulic rotary, including the building of the derrick, drilling, handling casing, fishing lost tools and the completion of the well, according to the best practice of the day. Supplementary chapters deal with oil and gas geology, cost of drilling, strength of materials and laws relating to gas and oil wells; other general information of use to the driller is also included.

Design of Steel Mill Buildings and the Calculation of Stresses in Framed Structures. By Milo S. Ketchum. Fourth edition, rewritten. McGraw-Hill Book Co., Inc., New York, 1921. Fabrikoid, 6×9 in., 632 pp., illus., diagrams, $6.

Covers the calculation of the stresses in framed structures and also the design of buildings having a self-supporting steel frame with a light covering, usually fireproof. In this edition the book has been rewritten, enlarged and reset. It is intended as a textbook in structural engineering and also as a book of reference for engineers.

Part 1 covers the calculation of the stresses in simple beams, trusses, portals, the transverse bent and the three-hinged arch. Part 2 covers the calculation of the deflections of structures, the stresses in statically indeterminate girders, trusses and frames, and secondary stresses in trusses. Part 3 covers the design of steel frame buildings for mines, mills, smelters and other industrial plants. The appendix is a complete specification for steel frame mill buildings.

Elements of Fractional Distillation. By Clark Shove Robinson. First edition. McGraw-Hill Book Co., Inc., New York, 1922. (International chemical series.) Cloth, 6×8 in., 205 pp., tables, diagrams, $2.50.

This book explains the principles of fractional distillation and illustrates them by carefully selected examples of their application. The first portion of the book treats of fractional distillation from the qualitative viewpoint of the phase rule; the second discusses some quantitative aspects from the engineering point of view; and the third section treats of the design of distilling apparatus. Part four gives examples of modern apparatus for distilling ammonia benzolized wash oils and alcohols. An appendix of useful tables is included.

Essentials of Industrial Costing. By George S. Armstrong, D. Appleton and Co., New York, 1921. Cloth, 6×9 in., 297 pp., tables, forms, $5.

This book is concerned solely with the principles and methods by which the cost of production may be determined. It is based upon an extended experience in many different industries and represents the author's mature views. The book shows the purpose of costing, summarizes good practice and is a guide to the analysis necessary for the establishment of costing systems.

ETUDE GEOMETRIQUE DES TRANSFORMATIONS BIRATIONNELLES ET DES COURBES PLANES. By Henri Malet. Gauthier-Villars et Cie, Paris, 1921. Paper, 7×10 in., 259 pp., diagrams, 32 fr.

A study, by synthetic methods, of birational transformations and plane curves. It strives particularly to establish the first principles and to set forth precisely, in logical and geometrical fashion, the conditions under which the homographic correspondence of laws is based. The author's exposition of modern geometry is based on the methods of Chasles and Poncelet.

HANDBUCH DER DRAHTLOSEN TELEGRAPHIE UND TELEPHONIE. By Eugen Nesper. Julius Springer, Berlin, 1921. Cloth, 7×10 in., 2 vol., illus., diagrams.

Dr. Nesper's book on radio communication attempts an exhaustive survey of the subject from a modern point of view and from every aspect. It is apparently more extensive than any previous work on the subject. It has been planned for easy reference, the material having been so arranged that each chapter is a complete account of a certain topic, so that reference to other chapters, or systematic reading of the whole work, can be avoided. The theory of radio communication, its history, uses, the measuring and detecting instruments, the physical phenomena in quasi-stationary circuits, coupling, damping, radiating, the technique and apparatus of high frequency measurements are described in volume one. Volume two describes typical radio stations for different purposes, and their apparatus, the uses of radio communication in railroading and radio telephony. It also includes a valuable bibliography of the important books and articles. Good indexes are provided.

HISTORY OF AERONAUTICS. By E. Charles Vivian. Harcourt, Brace and Co., New York, 1921. Cloth, 6×9 in., 521 pp., plates, portraits, $5.

The author of this work says that hitherto there has been no attempt to furnish a detailed account of how the aeroplane and the dirigible of today came into being, but each author has devoted his attention to some special phase or period. In this book he attempts to record the facts of development and to state, as fully as is possible within the compass of a single volume, how flight and aerostation have evolved.

HYDROELECTRICAL ENGINEERING. By Richard Muller. G. E. Stechert & Co., New York, 1921. Cloth, 7×10 in., 431 pp., diagrams, $6.

A systematic exposition of those principles of hydraulic and electrical engineering which underly the design of hydroelectric plants. Intended for engineers engaged in designing and constructing plants or reporting on their commercial possibilities.

HYDRAULICS AND ITS APPLICATIONS. By A. H. Gibson. New edition, revised and enlarged. D. Van Nostrand Co., New York, 1921. Cloth 6×9 in., 813 pp., illus., diagrams, $6.

This book opens with a description of the physical properties of water, followed by a brief treatment of the fundamentals of hydrostatics. The science of hydraulics is then presented, first theoretically and then with regard to its application to the design of hydraulic machinery. The work is written primarily for students, but the author hopes it may also prove of value to those actively engaged in the practice of hydraulic engineering. This edition has been practically rewritten, with considerable additions and much rearrangement of the material.

LA LOI DE NEWTON EST LA LOI UNIQUE. By Max Franck. Gauthier-Villars et Cie, Paris, 1921. Paper, 6×10 in., 158 pp., 12.50 fr.

The question considered in this book is whether it is possible, with our present knowledge, to formulate the law governing the mechanism of the universe. Upon two postulates, that all potential energy resides in the absolute space of the physicist, and that all matter is formed of an element of inertia movable in space, the author erects a hypothesis, and compares its consequences with known facts, to determine how nearly the two agree. The first consequence is the confirmation of Newton's law, which may now be given its exact interpretation; this is the reason for the title given the book. The author's theory uses only the notions of space, time, force and inertia admitted in Euclidean geometry and mechanics.

MANUFACTURE AND USES OF EXPLOSIVES. By R. C. Garner. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. (Technical primer series.) Cloth, 4×6 in., 116 pp., diagrams, $0.85.

Information on explosives is so scattered and so much concerned with the details of individual explosives, that some difficulty is experienced in obtaining a general view of the nature and functions of explosives. The present work endeavors to provide this within a short compass, dealing first briefly with the historical development of explosives, and then with the manufacture and use of those most used today. Includes a brief bibliography.

DIE PRESSLUFTWERKZEUGE. By P. Iltis. Second revised edition. Vereinigung Wissenschaftlicher Verleger, Berlin, 1921. (Goschen Collection.) Cloth, 4×6 in., 117 pp., illus.

After a brief general and historical introduction, this little book treats of the application of compressed air to hammers, percussion drills, punching, stamping and riveting machinery, drills, hoists and blasting machines. Within its limits, a large amount of information is given on the practical uses of compressed air.

SPECIAL LIBRARIES DIRECTORY. Edited by Dorsey W. Hyde, Jr. Special Libraries Association, Washington, 1921. Paper, 6×9 in., 123 pp. $2.

This directory is a comprehensive survey of the specialized collections of literature upon various subjects in the United States. Over 1300 libraries belonging to universities, societies, business houses and other agencies are listed, with their location, rules for use and brief accounts of their resources. The list is arranged by subject and also geographically. Many of these libraries are concerned with engineering and allied subjects. The list will prove valuable to research students, in indicating possible sources of information.

STEAM BOILER MAINTENANCE. By Reg. Clayton. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. (Pitman's technical primers.) Cloth, 4×6 in., 118 pp., diagrams, $0.85.

This brief account of good practice is clearly written in language devoid of unnecessary technicalities. The author hopes it will illustrate how breakdowns may be avoided and maintenance costs reduced by systematic supervision. It is not intended to be a guide for firemen so much as to show the weak spots in the apparatus and to lead to the discovery and remedying of incipient defects and malpractices.

SYSTEM BUILDING AND CONSTRUCTIVE ACCOUNTING. By Raymond D. Willard. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 307 pp., forms, $4.

A textbook for students of accounting, devoted to the design of systems for various lines of business. The book analyzes a number of systems in use, thus illustrating the principles involved, and illustrates by charts and forms suitable methods for the necessary records.

DIE WARMWASSERBEREITUNGS, UND VERSORGUNGSANLAGEN. By Wilhelm Heepke. Second edition, revised and enlarged. R. Oldenbourg, München, 1921. (Oldenbourgs Technical Handbook No. 5.) Paper, 6×9 in., 706 pp., diagrams, 120 M.

An exhaustive treatise on the installation of hot water plants, covering the subject in great detail. Confined to water-heating systems for domestic and industrial use. Methods of heating, boilers, piping, regulating and measuring instruments, insulating, etc., are fully covered.

WHARF MANAGEMENT, STEVEDORING AND STORAGE. By Roy S. MacElwee and Thomas R. Taylor. Appleton and Co., New York, 1921. Cloth, 6×9 in., 350 pp., forms, diagrams, tables, $5.

This, it is said, is the first book to deal comprehensively with wharf administration, the loading and unloading of cargoes, and the handling and storage of outward and inward freight. It describes the duties of pier superintendents, receiving clerks, tally men and foremen of stevedores. Other chapters deal with wharf layout and construction, cargo-handling machinery, longshoremen, labor problems. Particular attention is given to the economic aspects of the subject.

THE ENGINEERING INDEX

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THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

AERONAUTICS

Research. Aeronautic Research, Joseph S. Ames. Jl. Franklin Inst., vol. 193, no. 1, Jan. 1922, pp. 15-28, 17 figs. Describes types of investigations in progress in aeronautics and methods pursued, with especial reference to wind-tunnel experiments.

The Importance of Research in Aeronautics. Flight, vol. 14, no. 4, Jan. 26, 1922, p. 55. An epitome of views of Council of Royal Aeronautical Soc. on need for better safeguards to prevent submerging of applied scientific research in aeronautics by technical experimental work.

AIR

Liquefaction and Separation. The Liquefaction and Separation of Air (Luftverflüssigung und Luftrennung), Richard Linde. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 52, Dec. 24, 1921, pp. 1356–1360, 4 figs. Air liquefaction considered as connecting link between the compressed-air and refrigerating industry; physical principles, and the different working processes. Notes on air separation; arrangement of large modern plants; present efficiency and future prospects.

AIR COMPRESSORS

Piston. Modern Piston Compressors (Neuzeitliche Kolbenkompressoren), P. Ostertag. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 52, Dec. 24, 1921, pp. 1325–1332, 28 figs. Points out increasing importance of compressed air and its influence on design of piston compressors. Notes on standardization and simplification, drive and regulation. Experimental results with modern types of German low- and high-pressure compressors.

Sullivan Angle-Compound. Angle-Compound Air Compressors at a Colliery. Engineer, vol. 133, no. 3448, Jan. 27, 1922, pp. 111–112, 5 figs. Details of compressor installed at Bowden Close Colliery near Newcastle-on-Tyne, England, consisting of two angle-compound compressors made by Sullivan Machy. Co., Chicago, arranged on each side of, and driven in common by, a 350-hp. Allis-Chalmers self-starting synchronous motor.

Turbo-Compressors. Turbo-Compressors and Blowers (Turbokompressoren und -gebläse), H. Baer. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 52, Dec. 24, 1921, pp. 1333–1338, 14 figs. Notes on operation, basis of calculation and construction of modern turbo-compressors; speed, number of stages, losses, housing and intermediate cooling, regulation. The so-called "pumping" and its prevention. Comparison of piston and turbo-compressors. Useful field.

AIR CONDITIONING

Aero-Hydro-Fan-Separator. Improvements in the Process for Drying and Cleaning Air Mechanically, William J. Baldwin. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 1, Jan. 1922, pp. 49–52, 1 fig. Describes recent improvements made in fan known as an aero-hydro-fan-separator, for washing, drying and conditioning air.

Factories. Industrial Hygiene in Workshops (Ueber gewerbehygienische Einrichtungen in Arbeitsräumen), Otto Brandt. Glasers Annalen, vol. 89, no. 12, Dec. 15, 1921, pp. 149–152, 3 figs. Notes on dust-removal plants, most important parts of which are (1) exhaustor, (2) draft tubes, (3) pressure tubes, and (4) centrifugal dust separator; suction plants for drawing off of smoke, gases and acid fumes; and installations for utilization of flue-gas waste heat for generation of warm air.

Novel Scheme For Regulating Humidity in an Airplane Propeller Factory, A. C. Knauss. Heat. & Vent. Mag., vol. 19, no. 1, Jan. 1922, pp. 33-36, 4 figs. Details of air-conditioning apparatus developed at U. S. Forest Products Laboratory at Madison, Wis. From paper published by Forest Prod. Laboratory in Coöperation with Univ. of Wis.

AIRCRAFT

Armament Limitation Conference. Text of the Conference Discussion on Aircraft. Aerial Age Weekly, vol. 14, no. 21, Jan. 30, 1922, pp. 490–492. Text of official communiqué issued by Conference on Limitation of Armament dealing with discussion of aircraft in session of Committee on Limitation of Armament.

The Washington Conference and Aircraft. Aviation, vol. 12, no. 5, Jan. 30, 1922, pp. 128-132. Report of Sub-committee on limitation of aircraft as to numbers, character and use.

Maintenance. Canadian Technical Memoranda. Aviation, vol. 12, no. 4, Jan. 23, 1922, pp. 105-106. Copy of technical memoranda issued by Canadian Air Board, on aircraft maintenance.

Strength of Great Powers. Air Strength of the Great Powers. Aviation, vol. 12, no. 6, Feb. 6, 1922, pp. 164–166. Tables prepared by sub-committee on aircraft of Washington Conference giving authorized and actual air strength data for United States, France, Great Britain, Italy and Japan.

AIRPLANE ENGINES

Fuel Pump. The "Sylphon" Fuel System for Liberty "12" and Wright Model "H" Engines. Aerial Age Weekly, vol. 14, no. 19, Jan. 16, 1922, pp. 440–442, 5 figs. Describes sylphon pump designed to fill need for an engine-driven fuel pump to obviate use of air pressure where sufficient gravity head is not available. From Air Service Information Circular, vol. 3, no. 281.

Installation. Engine Installation, R. K. Bagnall-Wild. Flight, vol. 14, no. 4, Jan. 26, 1922, pp. 56–57. Discusses need for improvement, and principal features which are required for evolution of a sound installation.

Tests. British Tests for Aircraft Engines, Aerial Age Weekly, vol. 14, no. 19, Jan. 16, 1922, pp. 438–439. Gives schedule of standard tests to determine airworthiness of aircraft engines, issued by British Air Ministry.

AIRPLANE PROPELLERS

Levasseur Adjustable. The Levasseur Adjustable Propeller (L'hélice à pas variable Pierre Levasseur). L'Aerophile, vol. 29, no. 23–24, Dec. 1–15, 1921, pp. 18–19, 2 figs. Especially useful for flying at high altitude.

AIRPLANES

Aerofoils. New Method for Testing Aerofoils in Flight, F. H. Norton. Aviation, vol. 12, no. 5, Jan. 30, 1922, pp. 134–136, 4 figs. Consisting in suspending an aerofoil from an airplane and measuring resultant force by tension in wires. N. A. C. A. Technical Note No. 77.

Bombers. The Wibault Night Bomber. Flight, vol. 14, no. 2, Jan. 12, 1922, pp. 21–22, 2 figs. French all-metal airplane; wing spars built of duralumin sheet; engine, 600-hp. Renault; speed at 6500 ft., 125 m.p.h.; total loaded weight, 9450 lb.

British. Aeronautics in 1921. Engineer, vol. 133, no. 3445, Jan. 6, 1922, pp. 18–21, 13 figs. partly on supp. plate. Review of British airplanes constructed during year.

Commercial. The "Bristol" 10-Seater Commercial Aeroplane. Flight, vol. 14, no. 3, Jan. 19, 1922, p. 39, 1 fig. 400-hp. Bristol "Jupiter" engine; speed at ground level, 112 m.p.h., speed at 5000 ft., 110 m.p.h.

The D.H. Type 34 Commercial Biplane. Flight, vol. 14, no. 1, Jan. 5, 1922, p. 4, 3 figs. 450-hp. Napier "Lion" engine; wing area, 590 ft.; weight, empty, with water, 3365 lb.; useful load, 10 passengers, 2000 lb. freight, 80 gal. petrol; cruising speed, 105 m.p.h.

Development. Short Survey of the Development of Air Traffic (Kort overzicht over de ontwikkeling van het luchtverkeer, met inleiding tot het bezoek aan den Rijks Studiedienst voor de luchtvaart), E. B. Wolff. Ingenieur, vol. 36, no. 52, Dec. 24, 1921, pp. 1022–1031, 15 figs. Discusses especially form and stability, strength and safety, size of crew and comfort of arrangement.

Fokker. The Fokker F4 Passenger Transport Airplane. Aviation, vol. 12, no. 6, Feb. 6, 1922, p. 169, 2 figs. Latest design of A. Fokker is powered with 400-hp. Liberty; carries 10 passengers and hand baggage; high speed, 106 m.p.h.

Helicopters. See HELICOPTERS.

Huff-Daland Biplanes. The Huff-Daland Thick Wing Biplanes. Aerial Age Weekly, vol. 14, no. 22, Feb. 6, 1922, pp. 514–515, 522 and 531, 4 figs. Describes the HD-9A with 10 cylinder Anzani engine, and the "Petrol" HD-8A, a further development of this machine, incorporating OX-5 motor as power plant. See also Aviation, vol. 12, no. 6, Feb. 6, 1922, pp. 161–163, 2 figs.

Mummert Sport. The Mummert "Baby Vamp" Sportplane. Flight, vol. 14, no. 3, Jan. 19, 1922, pp. 40–41, 3 figs. Air-cooled twin-cylinder engine, developing 25-hp. at 1800 r.p.m.

Rib Forms, Strength of. The Strength of Airplane Rib Forms, D. T. Brown and R. J. Diefenbach. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 110–111. Description of investigation to determine strength of plywood webs, with lightening holes arranged as in airplane ribs.

AIRSHIPS

Commercial. Traffic Airships With Special Reference to Economy, Walther Leyenstetter. Aerial Age Weekly, vol. 14, nos. 21 and 22, Jan. 30 and Feb. 6, 1922, pp. 495–498 and 520–522, 8 figs. Jan. 30: Flight altitude and efficiency; flight speed; distance flown and useful load. Results so far obtained from practical experiments. Feb. 6: How airships should be constructed in order to fulfill economical conditions of purpose for which it is designed; establishment of an airship line; costs of operation and upkeep. Translated from Zeit. für Flugtechnik und Motorluftschiffahrt.

Goodyear Military. New Goodyear Military Airship, H. T. Kraft. Aviation, vol. 12, no. 4, Jan. 23, 1922, pp. 101–102, 2 figs. Nonrigid; 180,000 cu. ft. capacity; geared propellers driven by two 135-hp. Aeromarine type U-6-D engines speed, 60 m.p.h.

Rigid. Rigid Airships, Garland Fulton. U. S. Naval Inst. Proc., vol. 47, nos. 10 and 11, Oct. and Nov. 1921, pp. 1565–1591 and 1697–1723, 21 figs. Oct.: Discusses German, British, French and Italian developments. Nov.: Modern types of rigid airships, and developments in United States.

Semi-Rigid vs. Rigid. Semi-Rigid v. Rigid Airships, Umberto Nobile. Flight, vol. 14, no. 4, Jan. 26, 1922, pp. 49–50, 2 figs. Discusses the Roma, Italian semi-rigid, and the German or Zeppelin type, and advantages of Roma over Zeppelin. From Giornale del Genio Civile.

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NOTE.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

ALCOHOL

Tropical-Plant Fuel Alcohol. Possibilities of the Plant Growth of the Moist Tropics to Furnish Materials for Liquid Fuel, H. N. Whitford. Jl. Indus. & Eng. Chem., vol. 14, no. 2, Feb. 1922, pp. 151–152. Reviews possibility of tropics to produce crops of foodstuffs and wood capable of application to manufacture of cellulose and alcohol.

ALLOY STEELS

Shock Tests. Shock Tests on Notched Bars (Die Beurteilung der Kerbschlagprobe), H. Moser. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 2, Jan. 14, 1922, p. 43. Results of tests for which carbon steels of low and medium tenacity and a nickel steel of high tenacity were used, from each of which standard bars of different widths were made.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Copper. See COPPER ALLOYS.

Iron. See IRON ALLOYS.

ALUMINUM

Brittleness of. Brittleness Developed in Aluminum and Duralumin by Stress and Corrosion, Henry S. Rawdon, Alexander I. Krynitsky and Julius F. T. Berliner. Chem. & Met. Eng., vol. 26, no. 4, Jan. 25, 1922, pp. 151–158, 13 figs. Aluminum is deeply corroded where impurities lodge between primary grains, but, if recrystallized, is note mbrittled; duralumin is subject to true intercrystalline embrittlement, but intensified by corrosion and stress.

Flasks, Manufacture of. Manufacture of Aluminum Flasks (Herstellung von Aluminiumflaschen), Karl Rieger. Werkstattstechnik, vol. 16, no. 1, Jan. 1, 1922, pp. 1–3, 24 figs. Describes process of manufacture from original aluminum sheet to finished product.

ALUMINUM ALLOYS

Aluminum-Silicon. A New Light Alloy (Silumin, eine neue Leichtlegierung), J. Czochalralski. Zeit. fur Metallkunde, vol. 13, no. 14, Nov. 1921, pp. 507–510, 12 figs. Describes new alloy called silumin, consisting of aluminum and silicon refined through certain additions. It is claimed that its structure and technological properties are superior to similar casting alloys, and its use greatly increases possibilities of employing light alloys for structural purposes.

Bronzes. Macrography and the Pouring of Aluminum Bronzes (Emploi de la macrographie pour la mise au point de la coulée du bronze d'aluminium), J. Galibourg and A. Brizon. Révue de Métallurgie, vol. 18, no. 12, Dec. 1921, pp. 780–786, 15 figs. Difficulties of pouring, especially pipe; use of coolers, their position, etc.

Die Casting. Aluminum and Its Alloys—VI, F. A. Livermore. Metal Industry (Lond.), vol. 20, no. 2, Jan. 13, 1922, pp. 25–29, 7 figs. Deals with aluminum alloy die casting.

AMMONIA

Synthesis of. Synthesis of Ammonia (La recherche scientifique, ses applications a l'industrie et la synthèse industrielle de l'ammoniaque), Georges Claude. Révue Générale des Sciences, vol. 32, nos. 19 and 20, Oct. 15 and 30, 1921, pp. 534–543 and 570–581, 10 figs. Oct. 15: Difficulties of scientific research, its resources, etc.; manufacture of hydrogen, chlorine, helium, neon, etc. Oct. 30: Describes equipment and operations at Montereau Ammonia Extraction works working at a pressure of 1,000 atmos.

AMMONIA COMPRESSORS

Starterless Induction Motors for. Starterless Induction Motors for Ammonia Compressors, J. Lebovici. Ice & Refrigeration, vol. 62, no. 1, Jan. 1922, pp. 24–25. Describes starterless motor, combining favorable characteristics of squirrel-cage and slip-ring types, making an ideal drive for ammonia compressors using up to 150 hp. Paper read before Nat. Assn. Practical Refrig. Engrs.

AUTOMOBILE ENGINES

Air-Cooled. Air-Cooling Systems: Past, Present and Future. Autocar, vol. 28, no. 1369, Jan. 14, 1922, pp. 47–50, 7 figs. Gives concise summary of the various points for and against use of air-cooled engines for small cars; directions in which developments must tend.

Single-Cylinder Air-Cooled Sleeve-Valve Motor-Cycle Engine. Engineering, vol. 113, no. 2924, Jan. 13, 1922, pp. 44–45, 9 figs. Details of Barr and Stroud engine with 70-mm. bore and 90.5-mm. stroke, giving capacity of 349 cc., said to be first application of this type of engine to automobile work.

Braking Tests. Braking Tests with Automobile Engines (Kurze Anleitung zu Bremsversuchen an Kraftwagenmotoren), A. Heyne. Allgemeine Automobil-Zeitung, vol. 22, nos. 19 and 20, May 7 and 14, 1921, pp. 37–39 and 36–38, 1 fig. Notes on determination of brake power, torsional moments, mean piston pressures, fuel consumption, and pumping efficiency. Gives example of how to conduct tests.

Cylinders. Cylinders for the Mack Motor, Fred. H. Colvin. Am. Mach., vol. 56, no. 5, Feb. 2, 1922, pp. 173–174, 7 figs. Fixtures, trams and gages for locating cylinder from bore. Inspection methods which secure results. Volume of compression chamber tested by liquid gage.

Operations on the Cylinders of the Wills Sainte Claire, Fred H. Colvin. Am. Mach., vol. 56, no. 5, Feb. 9, 1922, pp. 216–218, 12 figs. Closed end cylinders require special tools for machining combustion chambers. Special boring machine with inclined spindles. Heat-treatment removes strains.

Peugeot-Tartrais Direct-Injection. Peugeot To Produce Automotive Injection Engine, W. F. Bradley. Automotive Industries, vol. 46, no. 6, Feb. 9, 1922, pp. 269–271, 11 figs. Said to be capable of using any liquid fuel; two-stroke cycle; develops 50 hp. at 1250 r.p.m.; weight, 550 lb.; uses 0.397 lb. fuel per hp. hr. at full load and 0.484 lb. at quarter load. See also Commercial Vehicle, vol. 26, no. 1, Feb. 1, 1922, p. 31, 3 figs.

The Peugeot-Tartrais Engine. Autocar, vol. 48, no. 1370, Jan. 21, 1922, pp. 116–117, 8 figs. A 2-cylinder, 2-cycle, direct-fuel-injection power unit weighing 11 lb. per hp., allowing a wide choice for fuels.

Two-Stroke Cycle. A New Two-Stroke Engine. Autocar, vol. 28, no. 1369, Jan. 14, 1922, pp. 73–74, 2 figs. Describes three-cylinder two-cycle Wege motor. Each lower cylinder acts as a compressor for an adjacent upper cylinder, in which power impulse takes place.

The Two-Stroke Motor Car Engine, F. W. Lanchester and R. H. Pearsall. Engineering, vol. 133, nos. 2925 and 2926, Jan. 20 and 27, 1922, pp. 90–92 and 122–124, 16 figs. Investigation of principal factors controlling performance of such engines. Paper read before Instn. Automobile Engrs.

AUTOMOBILES

Alfa-Romeo. The 35–50 Hp. Alfa-Romeo Chassis. Automobile Engr., vol. 12, no. 159, Jan. 1922, pp. 2–6, 9 figs. Built by Nicola Romeo & Co., Milan. Main features are ease of inspection and facilities for repairs or replacements.

Berliet. The 20 hp. and 25 hp. Berliet Cars. Autocar, vol. 28, no. 1369, Jan. 14, 1922, pp. 59–60, 5 figs. Monobloc four-cylinder engines; unit principle of construction.

Bugatti and Hillman. Some 1922 Car Features. Auto, vol. 27, no. 2, Jan. 12, 1922, pp. 29–32, 13 figs. Particulars of new 16-valve 2.3-8-hp. straight-eight Bugatti; and the 11-hp. Hillman car, in chassis of which steel stampings are largely used.

Electric. A Modern Electric Passenger Vehicle, Herbert Chase. Automotive Industries, vol. 46, no. 6, Feb. 9, 1922, pp. 265–268, 6 figs. Describes new car of Rauch & Lang; weight of battery approximately 830 lb., distributed front and back; maximum speed, 28 m.p.h. in sixth controller position, and 25 m.p.h. in fifth.

Elgin. Elgin Chassis Has Been Completely Redesigned, P. M. Heldt. Automotive Industries, vol. 46, no. 3, Jan. 19, 1922, pp. 134–135, 4 figs. New model 700 is fitted with 6-cylinder valve-in-head type special Falls engine, new single-plate clutch, larger fan and radiator and new hand-brake on gear set.

Front-Axle Stubs. Machining Automobile Front Axle Stubs, F. Hickling. Machy. (Lond.), vol. 19, no. 487, Jan. 26, 1922, pp. 497–499, 7 figs. Discusses layout for a particular type of stub, which has been in use for over two years, on a production of 50 to 100 pairs per week.

Frontenac 4-Cylinder. New Four-Cylinder Car Has Brakes on All Wheels, J. Edward Schipper. Automotive Industries, vol. 46, no. 1, Jan. 5, 1922, pp. 5–6, 4 figs. Describes new Frontenac car designed by Chevrolet and Van Ranst. Chain-driven overhead camshaft and location of electrical units alongside gear set gives a clean-appearing power plant.

Gear Boxes. Notes on Motor Car Gearboxes, H. F. J. Orcutt. Automobile Engr., vol. 12, no. 159, Jan. 1922, pp. 22–30, 7 figs. Discusses principal defects relating to design, workmanship and material. Describes gear-tooth grinding process. Costs of production. Paper read before Instn. Automobile Engrs.

Manufacture. Cars in the Making. Autocar, vol. 47, nos. 1365, 1366 and 1367, Dec. 17, 24 and 31, 1921, pp. 1254–1255, 1289–1291 and 1341–1343, 18 figs. Dec. 17: Practical working out of designs by experimental work. Dec. 24: Describes methods by which raw materials are worked up into forms suitable for economic processes of machine-shop production. Dec. 31: Deals with preparation of tools and jigs, and explains methods of using lathe to secure interchangeability of parts.

Napier. The 40–50 Hp. Napier Chassis, Automobile Engr., vol. 11, no. 158, Dec. 1921, pp. 430–437, 20 figs. Describes frame, engine (6-cylinder block), clutch (single-plate), gear box, foot brake, transmission and rear axle, front axle and steering, etc.

Repair-Shop Practice. Automobile Repair Shop Practice. Machinery (Lond.), vol. 19, no. 485, Jan. 12, 1922, pp. 445–447, 4 figs. Describes methods and equipment commonly employed in automobile repair shop practice.

Service Equipment. Automotive Service Methods and Equipment, Howard Campbell. Am. Mach., vol. 56, no. 4, Jan. 26, 1922, pp. 125–127, 11 figs. Tools used for servicing Hudson and Essex Cars. Fixtures for testing and straightening. Attachments for lapping pistons and cylinders.

Wolseley Works. Famous British Works. Eng. Production, vol. 4, no. 70, Feb. 2, 1922, pp. 98–100, 6 figs. Describes works of Wolseley Motors, Ltd., Birmingham, engaged at present in manufacture of the 10-hp. Wolseley, the Wolseley "fifteen," and the 20-hp. car de luxe.

AVIATION

French Civil Transport. French Progress in Civil Air Transport, M. de Lavergne. Aviation, vol. 12, no. 6, Feb. 6, 1922, pp. 170–171. In three years French merchant air fleet expanded from 46 airplanes to 258, all of which are used on regular transport services.

Pilot and Aircraft Registration. Underwriters' Laboratories Aviation Record. Aviation, vol. 12, no. 6, Feb. 6, 1922, pp. 160–161, 1 fig. Gives first list of American pilot and aircraft registration, prepared at request of Nat. Aircraft Underwriters Assn., members of which are hereafter to require registration of aircraft which they insure against fire, theft, collision, stranding and sinking, etc.

B

BEARINGS, BALL

Design and Performance. Ball and Roller Bearings: Their Design and Performance, A. W. Macaulay. Engineering, vol. 113, no. 2925, Jan. 20, 1922, p. 87, 6 figs. Points out that principal conditions which bearing must fulfill are (1) capacity for taking combined radial and thrust load; (2) self-contained unit having no loose parts, and without necessity of any adjustment; (3) high fatigue limit; (4) lowest possible friction; (5) absence of vibration. (Abstract.) Paper read before Instn. Engrs. & Shipbuilders in Scotland.

BLAST FURNACES

Hot-Blast Stove Rating. Hot Blast Stove Rating, F. H. Willcox. Blast Furnace & Steel Plant, vol. 10, no. 1, Jan. 1922, pp. 29–32. Actual test data showing effectiveness of hot blast stove equipment as applied to a 600-ton blast furnace.

Rebuilt. Rebuilds Stack on Historic Site, Richard Peters, Jr. Iron Trade Rev., vol. 70, no. 5, Feb. 2, 1922, pp. 325–328, 5 figs. Furnace succeeding famous Warwick unit has been replaced, work involving construction of new stack, top and downcomers. New blast furnace has skip bridge with independent shear leg support.

BLOWERS

Roots. Hints on Repairing Roots Blowers, F. R. Parsons. Mech. World, vol. 71, no. 1830, Jan. 27, 1922, pp. 64–65, 3 figs. Maintenance and efficient upkeep of Roots pressure blowers; sources of trouble and suggested remedies; lubrication and belt troubles.

Turbo. Turbo-Boosters and Exhausters for Town Gas. Engineering, vol. 113, no. 2926, Jan. 27, 1922, pp. 105–106, 8 figs. partly on p. 108. Deals with some of later developments by The Bryan Donkin Co., Ltd., Chesterfield, England, particularly the Rateau turbo-blowers and fans.

BOILER EXPLOSIONS

Causes. A New Boiler Explosion, G. W. Atkinson. Power, vol. 55, no. 6, Feb. 7, 1922, pp. 206–207, 3 figs. Leakage near flange of bumped head led to investigation which disclosed dangerous crack. Breathing of head probable cause.

BOILER OPERATION

CO_2 Values, Interpreting. Effect of Coal on Excess Air in Boiler Operation, Hugh R. Carr. Power Plant Eng., vol. 26, no. 2, Jan. 15, 1922, pp. 112–114, 2 figs. Considerations to be taken into account in interpreting CO_2 values with different kinds of coal.

Efficient. The Necessity for and Savings Possible with Better Boiler-Room Operation, C. W. DeForest. Power, vol. 55, no. 4, Jan. 24, 1922, pp. 139–141, 3 figs. Deals with cost of fuel, organization, boiler-room instruments and records. (Abstract.) Paper read before Stoker Mfrs. Assn.

BOILER PLANTS

Ford Motor Co. Power House. A Large American Power Plant. Eng. Production, vol. 4, nos. 68 and 69, Jan. 19 and 26, 1922, pp. 61–64 and 85–88, 6 figs. Details of boiler equipment of Ford Motor Co. (Abstract.) Paper presented to Engrs. Soc. West. Pa., by George T. Ladd, with contributions by H. T. Savage and J. R. Le Valley.

Valuation. Valuation of the Boiler Plant, Allen F. Brewer. Combustion, vol. 6, no. 2, Feb. 1922, pp. 84–88. Notes on unit cost data; overhead charge estimation; salvage and service values.

BOILERS

Capacities. Boiler Capacities Obtainable per Cubic Foot of Furnace Volume, T. B. Stillman. Power, vol. 55, no. 5, Jan. 31, 1922, pp. 171–173, 3 figs. Detailed test results on boilers operating at as high as 658.9 per cent rating. In one case 2285 lb. of oil was burned per hr. per burner. Paper presented before Assn. Edison Illuminating Companies.

High-Pressure. High-Pressure Steam up to 60 Atmos. for Power and Heat Generation (Hochdruckdampf bis zu 60 at in der Kraft- und Wärmewirtschaft), O. Hartmann. Elektrotechnische Zeit., vol. 43, no. 2, Jan. 12, 1922, pp. 45–47, 2 figs. Describes high-pressure boiler for 60 atmos. developed by Wilhelm Schmidt, which can safely generate steam at this atmosphere and up to temperature of 480 deg. It has a grate surface of 1.42 sq. m. and total heating surface, including superheater, of 72 sq. m. and has generated steam up to 1340 kg. per hr. (Abstract.) Address and discussion before Soc. German Engrs.

Locomotive. See LOCOMOTIVE BOILERS.

Marine. See MARINE BOILERS.

BOILERS, WATER-TUBE

Kestner. Developments in Power Station Design. Engineer, vol. 133, no. 3446, Jan. 13, 1922, p. 41, 2 figs. Describes Kestner water-tube boiler which, it is claimed, has acquired favor in France, Belgium, Denmark, Germany, Russia and the Argentine.

Marine. A New Water-Tube Boiler For Merchant Ships. Mar. Engr. & Naval Architect, vol. 45, no. 532, Jan. 1922, pp. 10–11 and 40, 2 figs. Describes the Hawthorn-Armstrong patent boiler in which an effort has been made to combine in one unit a steam generator suitable for use in merchant ships and to provide a high degree of superheat.

BORING MACHINES

Machining Locomotive Brasses. Machining Locomotive Brasses on Boring Mill. J. H. Moore. Can. Machy., vol. 27, no. 2, Jan. 12, 1922, pp. 17–19, 9 figs. Importance of proper fixtures if maximum production is to be attained. Describes machining of a 9-in. globe valve.

BRAKES

Freight-Train Vacuum. Vacuum Brake Trials on the Great Northern Railway, Henry Fowler. Ry. Gaz., vol. 36, no. 3, Jan. 20, 1922, pp. 87–88 and 100, 3 figs. Results of trials in connection with application of vacuum brake for long freight trains carried out between Peterborough and Firsby. Paper read before Instn. Civil Engrs.

Railway Brakes for Heavy Traffic. Engineering, vol. 113, no. 2924, Jan. 13, 1922, p. 43. Abstracts of two papers read before Instn. Civ. Engrs., entitled, Control of Trains Considered in Relation to Increase of Weight and Speed, Combined with Reduced Headway, by Alan Wood Rendell; and Trials in Connection with the Application of the Vacuum Brake for Long Freight Trains, Henry Fowler and Herbert N. Gresley.

BRASS

British Industry. Modern Developments in the British Brass Industry, Ernest T. Smith. Can. Chem. & Metallurgy, vols. 5 and 6, nos. 12 and 1, Dec. 1921 and Jan. 1922, pp. 345–348 and 8–12. Discusses extent to which existing scientific and technical knowledge has been utilized in British brass industry as a whole and describes development resulting from its utilization. Melting and foundry practice; electric furnaces; extrusion of brass; hot pressing and forging; rolling-mill practice; annealing; composition of brasses and special alloys; research and its organization. Paper read before Am. Electrochem. Soc.

Rod. Modern Methods of Making Brass Rod. Brass World, vol. 18, no. 1, Jan. 1922, pp. 3–4, 9 figs. partly on pp. 5–7. Describes development of extrusion process and present-day extrusion machines.

Season Cracking. Experiences of Season Cracking during the Great War, Owen W. Ellis. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 193–200. Points out success which attended ordnance factories' practice of low-temperature annealing.

The Prevention of Season Cracking in Brass by the Removal of Internal Stress, H. Moore and S. Beckinsale. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 162–192, 22 figs. Reduction of stress by low-temperature annealing was studied in 70:30 brass cold-rolled to 120, 160, and 200 Brinell hardness, in elastically bent test-strips of each hardness, initally stressed to 11, 17, and 22 tons per sq. in. maximum tension at surface. Results are presented in tables and summarized.

Spontaneous Cracking. The Spontaneous Cracking of the Necks of Small Arm Cartridge Cases, W. C. Hothersall. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 201–208, 6 figs. Said to be due to existence of stress in neck of case arising in some operation or operations subsequent to semi-annealing.

BRONZE

Manganese. Manganese Copper, Jesse L. Jones. Metal Industry (N. Y.), vol. 20, no. 1, Jan. 1922, p. 7. Discusses its use in manufacture of manganese bronze, and methods of obtaining best results.

C

CABLEWAYS

Aerial. Automatic Aerial Tramway. Rock Products, vol. 25, no. 3, Feb. 11, 1922, pp. 26–27, 2 figs. Tramway at Clinchfield Products Corp. operating a barytes mine at Evington, Va., is reversible; hauls both coal and ore.

Track Cables. Tensions in Track Cables and Logging Skylines, Samuel Herbert Anderson. University of Washington Eng. Experiment Station Bul., no. 13, June 1921, 27 pp., 5 figs. Deals with problem of catenary loaded at one point. Equations are derived and properties of such catenary discussed. It is shown how tensions may be computed and what the condition is for maximum tension.

CAR WHEELS

Flange Lubrication. Automatic Lubricating Apparatus for Flanges of Wheels of Electric Cars (Appareil de graissage automatique pour les boudins des roues de voitures automotrices électriques), H. Strehler. Bul. Technique de la Suisse Romande, vol. 47, no. 26, Dec. 24, 1921, pp. 301–303, 5 figs. Describes apparatus for railroad use and one for street cars for lubricating when negotiating curves, without dropping oil on rails.

Machining. Correct Machining and Mounting of Wheels and Axles and the Necessity for Carefully Measuring Axles Removed from Cars so that Proper Credits can be Allowed, Chas. Petran. Official Proc. of Car Foremen's Assn. of Chicago, vol. 17, no. 3, Dec. 1921, pp. 16–29 and (discussion) 30–57, 3 figs. Discusses boring of cast iron wheels; fitting wheels to axles; wheel mounting pressure and its automatic registration; instructions to guard against wrong inspection of axles; rolled-steel wheels; etc.

Manufacture. Wheels for Railway Rolling-Stock. Ry. Gaz., vol. 35, no. 27, Dec. 30, 1921, pp. 1000–1002, 6 figs. Describes new process of manufacturing wheel centers of the solid disk type.

Steel-Tired. Cast-steel and Steel-tyred Wheels, H. W. Mellor. Machinery (Lond.), vol. 19, no. 486, Jan. 19, 1922, p. 479, 4 figs. Suitable thickness for steel tires, and rims for steel wheels.

Sandberg Sorbitic Steel for Tyres. Ry. Gaz., vol. 35, no. 27, Dec. 30, 1921, pp. 991–992 and 999, 6 figs. partly on p. 993. Improvements due to Sandberg process which add considerably to capacity of rolling stock and reduce occupancy of repair shops. See also Ry. Engr., vol. 43, no. 504, Jan. 1922, pp. 16–17 and 35, 6 figs.

CARS

Reclaiming Metal Roof Sheets. Reclaiming Sheets of Outside Metal Car Roofs. Ry. Age, vol. 72, no. 4, Jan. 28, 1922, pp. 275–276, 4 figs. Savings in car-repair costs are result of moderate expenditures for facilities.

CASE-HARDENING

Charcoal Carbonization. Carbonization With Wood Charcoal, H. Schagrin. Am. Soc. for Steel Treating Trans., vol. 2, no. 4, Jan. 1922, pp. 331–335 and (discussion) 335–338, 12 figs. Discusses tests made with drop forgings of acid bessemer steel which showed that charcoal was cheap and satisfactory casing material.

CAST IRON

Hardness Tests. Mechanical and Elastic Properties of Cast Iron and the Use of the Ball Hardness Test (Caractéristiqués méchaniques ét élastiques des fontes et utilisation de l'essai à la bille), Albert Portevin. Révue de Métallurgie, vol. 18, no. 12, Dec. 1921, pp. 761–779, 19 figs. Discusses tests required by French artillery for steeled iron shells, including elongation, compression, and hardness.

Malleable. American Malleable Cast Iron, H. A. Schwartz. Iron Trade Rev., vol. 70, nos. 5 and 6, Feb. 2 and 9, 1922, pp. 335–341 and 410–411, 14 figs. Mechanical effects of plastic deformation.

Malleableizing of White Cast Iron, Arthur Phillips and E. S. Davenport. Am. Inst. Min. & Metallurgical Engrs. Trans., no. 1117-S, 1922, 23 pp., 49 figs., and (in abstract) Min. & Metallurgy, no. 181, Jan. 1922, pp. 31–32. Presents data and observations resulting from series of experiments dealing with heat treatment and microstructure of commercial white cast iron and its derivative, malleable iron.

The Molding of Malleable Pig Iron (Aus der Formereitechnik des Tempergusses), Rudolf Stotz. Giesserei-Zeitung, vol. 19, no. 1, Jan. 3, 1922, pp. 1–5, 14 figs. Discusses difficulties encountered in molding of malleable iron due to its possessing strong shrinking and brittle properties, and makes suggestions for overcoming these difficulties.

Synthetic. Manufacture of Synthetic Cast Iron in the Electric Furnace, W. L. Morrison. Chem. & Met. Eng., vol. 26, no. 7, Feb. 15, 1922, pp. 312–316. Production on Pacific coast; detrimental effects of excessive dry slags; comparative operating costs.

Synthetic Cast Iron, Made in California, Larry J. Barton. Chem. & Met. Eng., vol. 26, no. 6, Feb. 8, 1922, pp. 270–271. Discusses production of iron from steel scrap and gives particulars of electric-furnace operations.

CASTINGS

Automobile. British Motor Castings Methods—III, Ben Shaw and James Edgar. Foundry, vol. 50, no. 3, Feb. 1, 1922, pp. 103–107, 23 figs. Making of patterns and coreboxes for a typical crankcase casting; detail and reasons for methods recommended.

CENTRAL STATIONS

Superpower, France. The Superpower Station at Gennevilliers (La supercentrale de Gennevilliers), L. D. Fourcault. Technique Moderne, vol. 13, no. 12, Dec. 1921, pp. 525–527, 9 figs. partly on supp. plate. Describes civil engineering work, including foundations, especially for machines.

CHIMNEYS

Calculation. Simplified Chimney Calculation (Vereinfachte Schornstein-Berechnung), Otto Hoffmann. Feuerungstechnik, vol. 10, nos. 6, 7 and 8, Dec. 15, 1921, Jan. 1 and 15, 1922, pp. 53–56, 65–68 and 79–82, 2 figs. Simple method is developed for determining, for all sizes and fuels, the correct chimney dimensions. Comparison of ten different methods of calculation.

CHROME-NICKEL STEEL

Krupp Rustproof. Krupp Rustproof Steel, Fritz Huth. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 120–121. Developed as result of investigations carried out at establishment during years 1909 to 1914 on corrosion of steel, and belonging to class of chrome-nickel steels. Translated from Metall-Technik, vol. 47, no. 17, Nov. 1, 1921, p. 123.

CHROME STEEL

Heat Treatment. The Heat Treatment of Special Steels in General and with Particular Reference to Chrome Steels (Ueber die Wärmebehandlung der Sonderstähle im allgemeinen und der Chrosmtähle im besonderen), E. Maurer and T. Hohage. Stahl u. Eisen, vol. 42, no. 2, Jan. 12, 1922, pp. 59–61. Deals with heat treatment of the steels, with special regard to notch test and tensile strength. (Abstract.) Mitteilung K.-W.-Inst. f. Eisenforschung, vol. 2, pp. 91–105.

Properties. Chromium Steels and Irons, Leslie Aitchison. Automobile Engr., vol. 11, no. 158, Dec. 1921, pp. 453–458, 5 figs. Discusses the three main advantages of alloy steels as against carbon steels, viz., high tensile strength, high toughness, ease in hardening and homogeneity in resulting product. Mechanical properties of chromium steels and irons. Paper read before Instn. Automobile Engrs.

CLUTCHES

Pomini Friction. The Pomini Friction Clutch. Engineering, vol. 113, no. 2925, Jan. 20, 1922, pp. 70–71, 32 figs. Partly on supp. plate. Describes clutch constructed by Societa Anonima Luigi Pomini, Castellanza, Italy, known as "Superpotente," and intended to transmit 3000 hp. at 330 r.p.m. It is suitable for coupling Diesel engines to propeller shafts in submersible boats. Several were delivered to Italian Navy for war service.

COLD STORAGE

Meat and Fish. On the Freezing of Food Stuffs, Martin Krause. Eng. Progress, vol. 3, no. 1, Jan. 1922, pp. 7–10, 6 figs. Discusses investigations carried out in Germany regarding process of freezing pork, beef and fish.

COLUMNS

Buckling. Buckling of Elastic Structures. Am. Soc. Civ. Engrs. Proc., vol. 48, no. 1, Jan. 1922, pp. 103–110, 1 fig. Discussion by George Paaswell of paper by H. M. Westergaard published in same journal (Nov. 1921.)

COMPRESSED AIR

High-Pressure Handling. Methods of Handling Very High Pressures, P. W. Bridgman. Compressed Air Mag., vol. 27, no. 1, Jan. 1922, pp. 17–19, 5 figs. Explains methods of packing pistons and joints in order to obtain pressures up to 500,000 lb. per sq. in.

CONDENSERS, STEAM

Surface. Measurement of Surface-Condenser Leakage by Electrolytic-Conductivity Method, Earl A. Keeler. Power, vol. 55, no. 4, Jan. 24, 1922, pp. 126–128, 6 figs. Discusses difficulties in applying electrical methods to measuring condenser leakage, and how some of these difficulties have been overcome. How measurements are made. Factors affecting accuracy of measurements.

CONNECTING RODS

Side Thrust Due to Obliquity. Side Thrust due to Obliquity of the Connecting Rod in a High Speed Reciprocating Engine, Tetsuji Sugihara. Technology Reports of Tôhoku Imperial University, vol. 2, no. 3, 1921, pp. 17–26, 7 figs. Writer seeks to obtain expression for side thrust due to obliquity of connecting rod, and expresses it graphically when these effects are taken into account.

CONVERTERS

Bessemer Side-Blown. New Side-Blown Bessemer Converter, T. Levoz. Mech. Eng., vol. 44, no. 2, Feb. 1922, p. 122, 1 fig. Historical account of development, with criticism of various types. Describes type developed by author and points out its advantages. Translated from Fonderie Moderne, no. 10, Oct. 1922, pp. 284–290, 3 figs.

CONVEYORS

Overhead System. Double-Rail Overhead Conveying System, G. L. Lacher. Iron Age, vol. 109, no. 6, Feb. 9, 1922, pp. 409–410, 5 figs. Safeguards against track-jumping. Trolleys have two, four or eight wheels, and can carry load of 3000 lb.

Steel Belt. Swedish Steel Belt Conveyors, Harry Carlson. Iron Age, vol. 109, no. 5, Feb. 2, 1922, pp. 321–323, 7 figs. Especially adapted to hot and sticky materials, which cannot be carried on rubber or fabric belts. Lower power cost.

Types. Conveying and Elevating Machinery, Gardner Mitchell. Eng. & Indus. Management, vol. 7, no. 4, Jan. 26, 1922, pp. 109–114, 6 figs. Deals with spiral or worm, screw, paddle, belt, gravity-bucket, tray, slat, push-plate or scraper, and drag-link conveyors; and chain, belt and bucket elevators. Paper read before (British) Instn. Mech. Engrs.

COOLING TOWERS

Recooling. The Recooling of Water in Self-Ventilating Tower Coolers (Ueber die Wasserrückkühlung mit selbstventilierendem Turmkühler), Carl Geibel. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 242, 1921, 98 pp., 128 figs. Tests carried out on experimental plant designed by author, in which different types of cooling towers and spraying nozzles were temporarily installed. Tests were conducted under widely differing atmospheric conditions with varying volumes of water and heat units. Results are given in equations indicating properties of the different cooling plants, and permitting comparisons between recirculated and fresh-water operation.

COPPER ALLOYS

Phosphor-Copper. Phosphor Copper, Jesse L. Jones. Metal Industry (N. Y.), vol. 20, no. 1, Jan. 1922, pp. 6–7. Discusses its increased use as a deoxidizer, and methods of obtaining best results.

CORROSION

Causes and Prevention. What It Pays to Know About Corrosion, G. A. Van Brunt. Factory, vol. 27, nos. 5 and 6, Nov. and Dec. 1921, pp. 621–623 and 763–766, 1 fig. and vol. 28, nos. 1 and 2, Jan. and Feb. 1922, pp. 49–52, 4 figs. and pp. 172–174. Nov.: Causes and best methods of preventing corrosion. Dec.: How coatings of various metals, variously applied, protect iron and steel. Jan.: Where to use coatings of paint and japan. Feb.: Oxides and phosphates: Where to use them as protective coatings.

Condenser Tubes. Results Achieved by the Corrosion Committee British Institute of Metals, Ernest E. Thum. Chem. & Met. Eng., vol. 26, no. 7, Feb. 15, 1922, pp. 301–306, 9 figs. Discusses failure of brass condenser tubes in marine service, caused by lodgment of solids which trap corrosive substances formed during process of slow general thinning.

Iron Pipe. Increasing the Safety against Rust and the Mechanical Resistivity of Iron and Iron Pipes (Fördern der Rostsicherheit und mechanischen Widerstandsfähigkeit von Eisenrohren bzw. Eisen), B. Haas. Zeit. für die gesamte Giessereipraxis, vol. 42, nos. 10 and 11, Mar. 5 and 12, 1921, pp. 141–143 and 155–157. Discusses preventive measures.

Zinc and Tin. Corrosion Patterns on Cold-Worked Tin and Zinc, Henry S. Rawdon, Alexander I. Krynitsky and Julius F. T. Berliner. Chem. & Met. Eng., vol. 26, no. 5, Feb. 1, 1922, pp. 212–213, 3 figs. Properties of tin and zinc after deep corrosion.

COST SYSTEMS

Relation to Production. The Costing System and Its Relation to Production, G. H. Hales. Eng. & Indus. Management, vol. 7, nos. 1, 2, 3 and 4, Jan. 5, 12, 19 and 26, 1922, pp. 17–19, 31–34, 63–65, 5 figs. Jan. 5: Writer demonstrates value of coördination between costs and production department. Jan. 12: Questions relating to "productive hours," departmental expenses and establishment charges. Feb. 19: Premium bonus tickets. Jan. 26: Outlined system in practice. See also Eng. Production, vol. 4, nos. 66 and 67, Jan. 5 and 12, 1922, pp. 7–10 and 31–34, and (discussion), no. 68, Jan. 19, 1922, pp. 66–67. Paper read before Instn. Production Engrs.

CRANES

Electric Runabout. An Electric Runabout Crane. Eng. Production, vol. 4, no. 70, Feb. 2, 1922, p. 115, 1 fig. Describes trackless mobile cranes built by Ransomes, Sims & Jefferies, Ltd., Ipswich, England.

Hoisting Motors for. New Control for Lowering Speed on Three-Phase Cranes (Eine neue Senkbremsschaltung für Krane in Drehstromanlagen), Chr. Ritz. Siemens-Zeit., vol. 1, no. 12, Dec. 1921, pp. 476–480, 3 figs. Instead of one three-phase hoisting motor, two half-size motors, rigidly connected, are used. Hoisting is done with both motors in parallel, as if they were a single unit, but in lowering a load the two motors are energized in opposite torque sense. Characteristic operating curves of such a hoisting motor are given.

Locomotive. Increasing the Scope of Locomotive Cranes. Ry. Age, vol. 72, no. 6, Feb. 11, 1922, pp. 365–367, 4 figs. Experiences of Lehigh Valley demonstrates that a wide range of work can be handled advantageously.

CRANKCASES

Machining. Machining the Mack Crankcase, Fred H. Colvin. Am. Mach., vol. 56, no. 7, Feb. 16, 1922, pp. 256–257, 10 figs. Describes unusual milling cutter. Zylol used for detecting cracks. Methods of boring and reaming. Gages for final inspection.

CRANKSHAFTS

Forging. Radiagraph Aids in Forging Crankshafts, Fred E. Rogers. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 26–28, 9 figs. Mechanically operated cutting torches for cutting heavy crankshafts, for preliminary cuts and cutting after cranks have been twisted through 120 deg.

Machining. A Crank-Arm Turning Machine, P. M. Heldt. Automotive Industries, vol. 46, no. 2, Jan. 12, 1922, pp. 77–78, 5 figs. Describes device which simultaneously turns non-circular contours of all of the arms of an engine crankshaft.

CUTTING TOOLS

Diamond. Manufacture and Use of Diamond Cutting Tools, Ellsworth Sheldon. Am. Mach., vol. 56, nos. 4 and 6, Jan. 26 and Feb. 9, 1922, pp. 140–142, 5 figs. and 210–212, 8 figs. Jan. 26: Polishing or lapping the stone; wire-drawing dies. Feb. 9: Diamonds for drawing dies; methods of reducing diamonds to dust.

D

DIE CASTING

Methods. How Diecastings Are Produced, Herbert Chase. Automotive Industries, vol. 46, no. 1, Jan. 5, 1922, pp. 21–25, 8 figs. Describes methods followed and various types of die-casting machines employed. Characteristics of various alloys.

Pressure. Pressure Die Casting. Metal Industry (Lond.), vol. 20, no. 1, Jan. 6, 1922, pp. 1–3, 2 figs. Advantages of die casting over other forms of manufacture. Discusses half-round bearing dies.

DIESEL ENGINES

Compressors for. The Use of Compressed Air in Diesel Engined Ships, William Reavell. North-East Coast Instn. Engrs. & Shipbuilders, advance paper no. 3222-P, for meeting Jan. 27, 1922, 16 pp., 26 figs. In author's opinion, main compressor of marine Diesel engines is usually made needlessly large, and better efficiency in operation and saving in cost, weight, power, etc., would be obtained if capacity were reduced. Discusses functions and construction of auxiliary compressors.

Deutz Compressorless. The New Deutzer Compressorless Diesel Engine (Der neue Deutzer kompressorlose Dieselmotor), H. Schneider. Oel- u. Gasmaschine, vol. 18, no. 12, Dec. 1921, pp. 186–188, 4 figs. Notes on design, operation and advantages of new compressorless horizontal Diesel engine, which can be operated with all heavy oils, including tar oil.

Flexibility. Diesel-Engine Flexibility, W. S. Burn. North-East Coast Instn. Engrs. & Shipbuilders advance paper, no. 3228-P, for meeting Jan. 6, 1922, 40 pp., 22 figs. Investigation of flexibility of Diesel engine with view to its application to direct-driven Diesel locomotive.

Fuel Injection. Devices for Injection of Fuel Oil with Use of Injection Air in Diesel Engines without Regulation of the Discharge Openings (Vorrichtungen zum Einspritzen von Brennöl unter Verwendung von Einblaseluft bei Dieselmaschinen ohne Regelung der Ausspritz-Querschnitte). Wirtschaftsmotor, no. 7, July 1921, pp. 19–21. Controversy between Max Lindemann and F. E. Bielefeld relative to article by Lindemann published in same journal (no. 4, p. 17) and article by Bielefeld published in Oel- u. Gasmaschine (no. 1, p. 1).

Manufacture. Production of Cylinders, Pistons and Segments for Combustion Engines (Fabrication des cylindres, pistons et segments des moteurs à combustion). L'Ouvrier Moderne, vol. 4, no. 10, Jan. 1922, pp. 407–410, 2 figs. Choice and treatmeat of metals used in manufacture for Diesel engines.

Marine, Nobel 1600 B.H.P. Nobel-Diesel Marine Engine, George J. Steinheil. Engineer, vol. 133, nos. 3448 and 3449, Jan. 27 and Feb. 3, 1922, pp. 91–93, 5 figs. partly on p. 102, and 126–128, 6 figs. Describes latest product of Swedish Nobel-Diesel Co., Ltd., at Nynashamn. Engine is of two-cycle single-acting direct reversible crosshead marine type with 2000 i.hp. and giving mechanical efficiency of 80 per cent. Result of official trials.

The Two-Stroke Diesel Engine for Ship Drive (Die Zweitakt-Dieselmaschine im Schiffsbetrieb), H. Flasche. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 3, Jan. 21, 1922, pp. 53–59, 33 figs. Design and operation of a new 2000-hp. engine with port valve gear, constructed by the Nobel-Diesel Corp., Nynashamn, Sweden. Gives results of tests and points out advantages of two-stroke cycle.

Merchant-Ship. Krupp's New Merchant-Ship Diesel-Engine, Otto Alt. Motorship, vol. 7, no. 11, Feb. 1922, pp. 99–103, 10 figs. Describes the Germaniawerft 2,000-i.hp. four-cycle-type marine oil engine. Acceptance tests.

DISTILLATION

Still Heating with Superheated Steam. Should Melting Kettles and Distillation Stills be Heated with Superheated Steam? (Sollen Schmelzkessel und Destillierblasen mit überhitztem Dampf geheizt werden?), H. Voss. Chemiker-Zeitung, vol. 46, no. 2, Jan. 5, 1922, pp. 17–18. Author explains why, in the manufacture of ceresin and distillation of sebacic acid, glycerine and mineral oil, he cannot recommend superheated steam for heating of still.

DRAWINGS

Dimensioning Dovetails. The Dimensioning of Dovetails on Drawings, H. M. Funnell. Am. Mach., vol. 56, no. 6, Feb. 9, 1922, pp. 221–222, 2 figs. System of giving all necessary figures and enabling checking. Two separate sketches made of each dovetail. Proper tolerances for each dimension.

DRILLING MACHINES

Heavy-Duty. Economy of Heavy-duty Drilling. Machinery (Lond.), vol. 19, no. 486, Jan. 19, 1922, pp. 472–477, 15 figs. Deals with the use of Colburn heavy-duty drilling machine for work where heavy cuts are required.

Jigs. Dividing Drill Jigs, Hubert Bentley. Eng. & Indus. Management, vol. 7, no. 1, Jan. 5, 1922, pp. 6–7, 4 figs. Engagement or disengagement of feed mechanism actuated by friction disks.

Multiple-Spindle. Some Special Machines for Intensive Production. Eng. Production, vol. 4, no. 68, Jan. 19, 1922, pp. 52–56, 7 figs. Describes different types of multi-spindle drilling machines developed by Defiance Machine Works, Defiance, Ohio.

Radial. Recent Machine Tool Developments, Joseph Horner. Engineering, vol. 113, no. 2927, Feb. 3, 1922, pp. 126–128, 43 figs. Describes 3-ft. 6-in. radial drilling machine constructed by James Archdale & Co., Ltd., Birmingham, England.

6-Ft. High-Speed Radial Drill. Engineering, vol. 113, no. 2923, Jan. 6, 1922, pp. 8–9, 9 figs. Describes machines manufactured by George Swift & Sons, Ltd., Halifax, running from 4 ft. 6 in. to 8-ft. radius.

DRILLS

Twist, High-Speed. Making the Latrobe High-Speed Twist Drill, S. Ashton Hand. Am. Mach., vol. 56, no. 7, Feb. 16, 1922, pp. 246–248, 9 figs. Steel rolled to obtain greatest density at points of wear. Flutes milled after twisting. Drills and shanks assembled by unusual methods.

DROP FORGING

Die Blocks. Die Blocks as Seen by the Drop Forge Plant, A. A. Blue. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 34–36. Qualities desired in a die block by various members of a drop-forge organization. Brief review of present practice and summary of established methods.

Die Blocks for Drop Forge Plant. Ry. Jl., vol. 28, no. 2, Feb. 1922, pp. 15–16. Desirable qualities of a die block. Brief review of present practice.

Fiber Stresses in Die Blocks, Leslie Aitchison. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 36–38, 2 figs. Emphasizes the appreciation that is given in England to the direction of the grain in die block with relation to maximum work to be done by the impression. Excerpt from address delivered before Assn. Drop Forgers & Stampers.

Stamps. Friction Lifters for Drop Stamps, W. H. Snow. Engineer, vol. 133, nos. 3446 and 3447, Jan. 13 and 20, 1922, pp. 34–36 and 60–62, 13 figs. Describes modified kick stamps, board drop stamps, and clutch-operated lifters.

Variables in. Variables in Drop Forge Practice, J. H. Nelson. Automotive Industries, vol. 46, no. 6, Feb. 9, 1922, pp. 274–276. Results of experiments in heat treatment of finished forgings; outlines five definite conclusions arrived at. Author states that there are seven possibilities of difference between drop forgings that are apparently identical.

E

ELASTICITY

Theory. Recent Progress in Theory of Elasticity (Neuere Fortschritte der technischen Elastizitätstheorie) L. Föppl. Zeit. für angewandte Mathematik u. Mechanik, vol. 1, no. 6, Dec. 1921, pp. 466–481. Review of literature of past decade on calculation of plates and cylindrical and spherical shells.

ELECTRIC DRIVE

Wire Mills. Electric Drives For Wire Mills. Blast Furnace & Steel Plant, vol. 10, no. 1, Jan. 1922, pp. 64–67, 7 figs. General description of modern electric drives recently installed in Alabama City works of Gulf States Steel Co.

ELECTRIC FURNACES

Counterflow-Car-Type. Counterflow Car Type Electric Furnace, Horace Drever. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 47–49, 5 figs. Describes in detail a furnace annealing gray cast iron, using the recuperative principle. Will anneal 20 tons of stock per 24-hr. day at 1450 deg. Fahr.; high thermal efficiency.

Heroult Steel. New 7-Ton Heroult Furnace. Iron Age, vol. 109, no. 5, Feb. 2, 1922, p. 325, 1 fig. Details of design capable of employing mechanical instead of hand charging.

Steel. The Present Status of Electric Furnaces in Steel Making, Harry Etchells. West of Scotland Iron & Steel Inst. Jl., vol. 29, Part 2, Nov., Session 1921–1922, pp. 2–7 and (discussion) 7–11, 1 fig. on supp. plate. Discusses various types of electric furnaces, especially the arc, and advantages of electric steel.

ELECTRIC LOCOMOTIVES

Lentz Hydraulic Drive. The Lentz Hydraulic Drive in Electric Locomotives (Das Flüssigkeitsgetriebe von Lentz in der elektrischen Lokomotive), H. Wittfeld. Elektrische Kraftbetriebe u. Bahnen, vol. 20, no. 1, Jan. 10, 1922, pp. 1–2. It is shown that possibility exists of improving electric locomotives with simple alternating current by installing a Lentz hydraulic driving gear between driver and driving axle, and that existing driver could be replaced by a synchronous driver.

Steam vs. Railway Electrification, Vincent Raven. Ry. Gaz., vol. 36, no. 1, Jan. 6, 1922, pp. 11–14, 3 figs. Some advantages which may result from substitution of electric for steam locomotive operation. Describes design of various classes of electric locomotives. Abstract of paper read before North-East Coast Instn. Engrs. & Shipbuilders. See also Engineering, vol. 113, nos. 2923 and 2924, Jan. 6 and 13, 1922, pp. 25–26 and 39–43, 13 figs. partly on supp. plate and on p. 48, and Electrician, vol. 88, no. 2277, Jan. 6, 1922, pp. 10–11, 1 fig.

Storage-Battery. Accumulator Locomotives for Steel Works. Iron & Coal Trades Rev., vol. 104, no. 2811, Jan. 13, 1922, pp. 43–44, 3 figs. Describes electric apparatus built by Sanderson Bibby Co.

ELECTRIC RAILWAYS

Insurance for. Insurance for Electric Railways. Elec. Ry. Jl., vol. 59, no. 2, Jan. 14, 1922, pp. 73–78. Discusses types of insurance applicable to railway organizations; an efficient aid in handling labor; affords opportunity for operating economies; suggestions for executive action.

ELECTRIC WELDING, ARC

Car-Wheel Flanges. Three Years Experience in Welding Worn Flanges, E. B. Gunn. Elec. Ry. Jl., vol. 59, no. 5, Feb. 4, 1922, p. 196. Satisfactory results have been obtained; wheel mileage has been increased greatly at small cost and with no bad results from a safety standpoint. Paper read before Central Elec. Ry. Assn.

Cast Iron. Arc-welding of Cast Iron, A. R. Allard. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 461–464, 6 figs. Use and application of methods for welding of cast iron by electric arc.

Increasing Welding Speed. Increasing Welding Speed, H. R. Pennington. Welding Engr., vol. 7, no. 1, Jan. 1922, pp. 24–25. Speed of electric arc welding can be increased by increasing electrode diameter and coating electrodes. Paper read before Am. Welding Soc.

Steel Structures. Electric Arc Welding in Steel Structures, James Caldwell. Engineering, vol. 113, no. 2925, Jan. 20, 1922, pp. 88–90, 4 figs. Gives examples of work done, and summary of test results to date, giving some idea of extent to which welds in steel structures can be relied upon. (Abstract.) Paper read before British Instn. Mech. Engrs.

ELEVATORS

Evolution of. Evolution of Mechanical Handling Devices of the Continuous Type. Eng. World, vol. 20, no. 2, Feb. 1922, pp. 90–91, 11 figs. Described in illustrations dating from 1560 B. C.

Power Application to. Electric Power Application to Passenger and Freight Elevators, Harrison P.

Reed. Am. Inst. Elec. Engrs. Jl., vol. 41, nos. 1 and 2, Jan. and Feb. 1922, pp. 57–67 and 152–164, 23 figs. Notes on history and service requirements; types of elevator machines and limitation of each; characteristics and limitations of d.c. and a.c. motors; elevator controllers; brakes and other safety accessories; power consumption. Paper prepared under auspices of Subcommittee on Elevators of Indus. & Domestic Power Committee.

EMPLOYEES, TRAINING OF

Foundry Workers. Industrial Training for Foundry Workers, Thos. Vickers. Foundry Trade Jl., vol. 25, nos. 283 and 284, Jan. 19 and 26, 1922, pp. 42–44 and 63–65, Jan. 19. Gives historical review. Discusses the Worshipful Company of Founders; improvements necessary in modern foundry conditions; effort of Cast Iron Research Assn. to modernize foundry production; etc. Jan. 26: American system and a German scheme.

EMPLOYMENT MANAGEMENT

Analyses of Working Force. How to Analyze the Working Force, Eugene J. Benge. Management Eng., vol. 2, no. 2, Feb. 1922, pp. 79–84, 8 figs. Notes on securing facts to establish labor policies and proper working conditions.

ENGINEERING SCHOOLS

Newark Technical School. College of Engineering of the Newark Technical School. Chem. Age (N. Y.), vol. 30, no. 1, Jan. 1922, pp. 11–14, 3 figs. Discusses origin and administration of college, coöperation with industry, chemical-engineering instruction, etc.

ENGINEERS

Coöperation of Chemists and. The Coöperation of the Engineer and Chemist in the Control of Plants and Processes, G. M. Gill. Gas Jl., vol. 157, no. 3061, Jan. 11, 1922, pp. 82–86 and (discussion) 86–89, 8 figs. Deals with coal and refractory materials and outlines system which has been applied with object of standardizing quality of gas. Paper read at joint meeting of (British) Instn. Mech Engrs. and Soc. Chem. Industry. See also Engineering, vol. 113, no. 2924, Jan. 13, 1922, pp. 57–59, 8 figs.

EVAPORATORS

Liquor Concentration. The Concentration of Liquors by Evaporation, James Holmes. Chem. Trade Jl. & Chem. Engr., vol. 70, no. 1807, Jan. 6, 1922, pp. 1–3. Notes on heat losses in evaporation; typical quadruple-effect performances; improvements in design of evaporators.

EXHAUST STEAM

Utilization. The Utilization of Exhaust Steam. Engineer, vol. 133, no. 3448, Jan. 27, 1922, pp. 109–110. Outline of two papers read before joint meeting of Instn. Elec. Engrs. and Instn. Heating & Ventilating Engrs., namely, Utilisation of Exhaust Steam from Electric Generating Stations and Coal Economy, by Ingham Haden; and Utilisation of Waste Heat from Electric Generating Stations, by F. N. Whysall.

F

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FANS

Low-Pressure. Low-Pressure Fans (Niederdruck-Ventilatoren), H. Hüttig. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 52, Dec. 24, 1921, pp. 1342–1344, 4 figs. Discusses different types, uses, and problems of drive.

Measuring Delivery. Standardized Method of Measuring Fan Delivery, E. N. Fales. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 1, Jan. 1922, pp. 1–10, 7 figs. Discusses the method as applicable not only to cooling fans, but also to larger-type propeller fans where flow is not enclosed.

FERROSILICON

Additions to Pig Iron. Ferrosilicon for the Improvement of Cast Iron (Ferro-Silizium). Zeit. für die gesamte Giessereipraxis, vol. 42, no. 53, Dec. 31, 1921, pp. 697–698. Writer gives results of his practical experiences with additions of silicon to charge, and points out that Fe Si in the form of E. K. packages is a very good medium for drawing of pig iron, and can be of great value when combined with other media.

FIRE PROTECTION

Rural Districts. Water Supply to Rural Districts for Fire-Extinguishing Purposes (Löschwasserbeschaffung in ländlichen Ortschaften), Bernard Peill. Feuerwehrtechnische Zeit., vol. 9, no. 11, Nov. 20, 1921, pp. 171–173, 2 figs. Discusses use of fire-brigade trucks with water tanks, water-scooping machines for supply of conduit or pipe systems, etc.

FLIGHT

Soaring. The Problem of Soaring Flight, A. P. Herff Aviation, vol. 12, no. 6, Feb. 6, 1922, p. 167, 3 figs. New theory based on observations of the turkey buzzard; requirements for reproducing soaring flight with airplanes.

FLOW OF FLUIDS

Commercial Pipe Lines. The Flow of Fluids through Commercial Pipe Lines, Robert E. Wilson, W. H. McAdams and M. Seltzer. Jl. Indus. & Eng. Chem., vol. 14, no. 2, Feb. 1922, pp. 105–119, 18 figs. Describes experimental work to fill in gaps in existing data on flow of fluids in pipes of commercial size and roughness, especially for very viscous liquids and in critical region between viscous and turbulent flow; and to determine correction factors for pressure drop around bends.

Turbulence. Experimental Investigations of Problem of Turbulence (Experimentelle Untersuchung zum Turbulenzproblem), L. Schiller. Zeit. für angewandte Mathematik u. Mechanik, vol. 1, no. 6, Dec. 1921, pp. 436–444, 7 figs. Study of conditions of stability of laminary and turbulent flow in smooth pipes.

The Origin of Turbulence (Bemerkungen über die Entstehung der Turbulenz), L. Prandtl. Zeit. für angewandte Mathematik u. Mechanik, vol. 1, no. 6, Dec. 1921, pp. 431–436, 3 figs. Results of investigations carried out by author on an open conduit, 6.5 m. long, with rectangular cross-section.

FLOW OF LIQUIDS

Viscous. The Flow of Viscous Liquids Through Slightly Conical Tubes, A. S. Hemmy. Physical Soc. of Lond. Próc., vol. 34, Part 1, Dec. 15, 1921, pp. 22–25 and (discussion) 25–26. Formula is obtained by neglecting terms containing the square of the obliquity.

FLOW OF WATER

Channels. The Discharge of Water in Raft Canals and Similar Channels (Der Wasserabfluss in Flossgassen u. ähnlichen Gerinnen), Ludwig Freytag. Forschungsarbeiten, no. 235, 1921, 85 pp., 15 figs. Contribution to theory of non-uniform movement of water.

The Movement of Water in Artificial and Natural Channels (Ueber die Bewegung des Wassers in künstlichen und naturlichen Gerinnen), Josef Putzinger. Zeit. des Oesterr. Ingenieur-u. Architekten-Vereines, vol. 74, no. 1–2, Jan. 6, 1922, pp. 4–8, 3 figs. Rules for flow of water in pipes, open channels and natural river beds, are developed which, it is believed, should be helpful in solving problem of distribution of velocity in flowing water.

Kutter's Formula. Kutter's Formula Simplified. H. E. Babbitt. Eng. & Contracting, vol. 57, no. 6, Feb. 8, 1922, p. 128. It is shown that apparent discrepancies introduced by use of modified form of formula for solution of problems ordinarily met are less than discrepancies introduced by difference of 0.001 in determination of value of n.

Pipes. Flow of Water through Spiral Riveted Steel Pipe, F. W. Greve and R. R. Martin. Purdue University Publications of Eng. Depts., vol. 5, no. 2, July 1921, 32 pp., 11 figs. Data and results of investigation upon flow of water through 4, 6, 8 and 10-in. galvanized spiral riveted steel pipes, in which effort was made to determine (1) variation of friction loss with velocity, for flow both with and against laps; (2) variation in accuracy of four types of piezometer rings; (3) comparison of friction loss with that in cast iron pipes for like conditions of diameter and velocity.

Prandtl Limit-Stream Theory. Problems of Flow and Transmission of Heat (Strömungs- und Wärmeübergangsprobleme), Max Jacob. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 53, Dec. 31, 1921, pp. 1374–1375, 1 fig. Refers to a number of articles published in Zeit. für angewandte Mathematik u. Mechanik (no. 4, 1921), most of which are based on so-called limit-layer theory of Prandtl, which is here discussed without mathematics in a manner intelligible to pratical engineers.

FLUIDS

Viscous, Motion of. The Two-dimensional Slow Motion of Vicous Fluids, L. Bairstow, B. M. Cave and E. D. Lang. Roy. Soc. Proc., vol. 100, no. A 705, Jan. 2, 1922, pp. 394–413, 7 figs. Discusses problems which require a solution of differential equation $\delta\psi = 0$.

FORGE PLANTS

Steam and Board Hammers. Comparison of Steam and Board Hammers, R. C. Jennings. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 28–29. Advocates board hammer for forging of light and medium heavy parts and steam hammer where considerable drawing or heavy forging is to be done.

Upset Forging. New Upset Forging Plant in Chicago, William E. Crocombe. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 20–22, 5 figs. Describes plant of Amforge Company, touching briefly on forge shop, die-sinking department, and inspection department.

Plant Makes Upset Forgings Exclusively. Iron Age, vol. 109, no. 6, Feb. 9, 1922, pp. 401–404, 5 figs. New shop of Amforge Co. is said to be unique because of its equipment, layout and methods of stores keeping, ventilating system, etc.

FORGES

Gas Forges. Use of Gas Forges in Repair Shops, J. L. Springer. Gas Age-Rec., vol. 49, no. 5, Feb. 4, 1922, pp. 133–134. Deals with temperature regulation, combustion gases, sulphur in burning gases, and bench forges.

FOUNDRIES

Gray-Iron. Complete Huge Wisconsin Foundry. Foundry, vol. 50, no. 3, Feb. 1, 1922, pp. 89–98, 15 figs. Describes new plant of Fairbanks, Morse & Co., with capacity of 500 tons per day of gray-iron castings varying in weight from 1 lb. to 15 tons.

FUELS

Bagasse, Calorific Value of. The Calorific Value of Bagasse, P. H. Parr. Int. Sugar Jl., vol. 24, no. 277, Jan. 1922, pp. 13–18. Determines heating value for bagasse, its composition, etc. Gives some comparative figures for wood.

Economy. A Session on Fuel Economy. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 112–113 and 118. Discussion of four papers at A.S.M.E. meeting, namely, Boiler Plant Efficiency, by Victor J. Azbe; Boiler and Furnace Economy, D. S. Jacobus; Fuel Saving in Relation to Capital Necessary, Joseph Harrington; and Fuel Saving in Modern Gas Producers and Industrial Furnaces, W. B. Chapman. Brings out many experiences in economic boiler and furnace operation, leading to great fuel savings.

Low-Grade. Recent Fuel Investigations. Power Plant Eng., vol. 26, no. 3, Feb. 1, 1922, pp. 162–164. Experiments conducted to determine feasibility of utilizing lower-grade fuels for steaming purposes.

[See also OIL FUEL; PULVERIZED COAL.]

FURNACES

Combination Welding and Preheating. Combination Welding—Preheating Furnace, F. M. Cloyd. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 84–85 and 89, 7 figs. Methods at plant of A. A. Simonds & Sons Co., Dayton, Ohio, using stoker-fired furnace for preheating and welding. Special tongs and metric clock increase production materially.

FURNACES, BOILER

Low-Grade Fuels. Step Grates, Semi-Producer-Type Furnaces, Forced Draft, and Coal Burned per Unit Grate Area (Treppenroste, Halbgasfeuerungen, Unterwind und Rostbelastung), H. Pradel. Braunkohle, vol. 20, no. 41, Jan. 14, 1922, pp. 641–648, 11 figs. Discusses efficiency of and gives results of tests with the Topf high-capacity and the Bergmann semi-producer furnaces, Pluto stoker, etc., for utilization of low-grade fuel.

FURNACES, HEATING

Forgings. Heating Furnaces For Forgings, C. Fischer. Blast Furnace & Steel Plant, vol. 10, no. 1, Jan. 1922, pp. 94–95, 3 figs. Discusses utilization of waste gases from heating furnaces, including direct preheating of steel by waste gases.

FUSION WELDING

Castings. Utilizing Fusion Welding on Castings, H. S. Rawdon. Iron Trade Rev., vol. 70, no. 4, Jan. 26, 1922, pp. 274–276. Includes table summarizing mechanical properties of low-carbon cast steel prepared by thermit process, and by arc-fusion. Discussion of paper entitled Fusion Welding, by S. W. Miller, presented at Am. Iron & Steel Inst.

G

GAGES

Adjustable Limit. The Wickman Adjustable Limit Gauge for Taps. Engineering, vol. 113, no. 2926, Jan. 27, 1922, pp. 100–102, 13 figs. Describes adjustable thread caliper gage which enables screws and externally threaded part to be controlled within any desired limits of accuracy in pitch, effective diameter, etc. Its use for tap inspection.

Error of Contact. Tests to Determine Error of Contact (Versuche zur Bestimmung des Berührungfehlers), Eugen Simon. Werkstattstechnik, vol. 16, no. 1, Jan. 1, 1922, pp. 6–8. Results of tests conducted by sub-committee on gage allowances of German Industries Committee on Standards (NDI), to determine error occurring in measurement of same hole with different gages brought about by giving to all gages the same diameter without regard to influence of varying sizes of their measuring surfaces.

Multiple-Spline, Grinding. Grinding Multiple Spline Gauges. Machinery (Lond.), vol. 19, no. 485, Jan. 12, 1922, pp. 449–450, 3 figs. Describes method of grinding multiple-spline gages having six or more splines, which has proved successful in practice.

Snap, Setting Machine for. Snap Gauge Setting Machine. Machinery (Lond.), vol. 19, no. 485, Jan. 12, 1922, pp. 439–440, 3 figs. Range of machine covers settings from $\frac{1}{2}$ up to 10 in., and the sensitiveness is to 0.0001-in.

GAS

Straw. Gas Made by Carbonizing Straw, Harry E. Roethe. Gas Age-Rec., vol. 49, no. 3, Jan. 21, 1922, pp. 75–76, 2 figs. Discusses destructive distillation of straw and similar material, and the gas producing plant on the government farms at Arlington, Va., for experimental work.

GAS ANALYSIS

Stack and Fuel. Graphical Treatment of Stack Gas Analysis and Fuel Gas Analysis, W. Trinks. Blast Furnace & Steel Plant, vol. 10, no. 1, Jan. 1922, pp. 50–58, 5 figs. Gives most important phases of work regarding charts introduced by Wa. Ostwald and laid out in book called "Beiträge zur graphischen Feuerungstechnik," on calculation for stack gas analysis for producer gas, natural gas, by-product tar, coke-oven gas, and for coal.

GAS PRODUCERS

German Bamag. Improvements and Operating Experiences with Gas-Producer Plants for Large Variety of Fuels (Neuerungen und Betriebsergebnisse von Gasgeneratoranlagen für die verschiedensten Brennstoffarten), H. Lichte. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 48 and 49, Dec. 2 and 9, 1921, pp. 385–387 and 396–399, 15 figs. Describes Bamag producers in the following constructions: revolving-grate producer with and without water-cooling jacket; high-pressure revolving-grate producer; and grateless producer.

Hot-Blast Application. Using Hot Air in Gas Producers for Fusing Ash (L'Emploi du vent chaud dans les gazogènes à fusion des cendres), A. Dessemond. Le Génie Civil, vol. 79, no. 26, Dec. 24, 1921, pp. 561–564, 1 fig. Describes installation of Société des Houillères de St. Etienne, showing success of system with fuel containing up to 60 per cent ash, as well as with heterogeneous fuels.

GASES

Cleaning. A New Process of Cleaning Gases and Vapors (Ein neues Verfahren zur Reinigung von Gasen und Dämpfen), E. Stach. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 49, Dec. 3, 1921, pp. 1265–1267, 7 figs. Points out that for removal from gases and vapors of dust, tar, oil, etc., according to the Freytag-Metzler rotary-filter process, a much greater degree of cleanliness is achieved than with methods heretofore in use. Writer recommends further development of process for removal of oil from vapor and air filtration.

Rotary-Type Gas Filter. Mech. Eng., vol. 44, no. 2, Feb. 1922, p. 126, 1 fig. Describes process intended to be used for removing dust, tar, oil and similar impurities from gases and vapors, developed by Freytag-Metzler and tested by E. Stach and Dr. Alexi. Translated from Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 49, Dec. 3, 1921, pp. 1265–1267, 7 figs.

Compressed, Steel Containers for. Explosions of Steel Flasks (Stahlflaschen-Explosionen). Zeit. für komprimierte u. flüssige Gase, vol. 21, nos. 9 and 11, 1920–21, pp. 104–105 and 128–129. Account of series of serious accidents which have occurred in the last years in the handling of compressed and liquid gases, and results of investigations.

Oxy-Hydrogen, Ignition Point of. Investigations of the Ignition Point of Oxy-Hydrogen Gas (Untersuchungen über den Entzündungpunkt des Knallgases), Alexander Mitscherlich. Zeit. für komprimierte u. flüssige Gase, vol. 21, nos. 8, 9 and 10, 1920–21, pp. 89–93, 101–103 and 125–128, 6 figs. Account and results of tests and description of testing apparatus. Article was published during war in Zeit für anorganische Chemie, vol. 98, from which above is reprinted.

GEAR CUTTING

Fixing and Releasing of Blanks. Rapid Holding and Releasing of Gear Blanks, Fred Horner. Can. Machy., vol. 27, no. 5, Feb. 2, 1922, pp. 40–41 and 46, 10 figs. Holding with spring collets of external or internal type; use of draw-back rod; etc.

Worm-Gear Machine. A New Worm Gear Generating Machine. Engineer, vol. 133, no. 3447, Jan. 20, 1922, pp. 78–79, 9 figs. New machine by Smith & Coventry, Ltd., Manchester, England, of tangent feed pattern, more particularly adapted to generation of single wheels or wheels in small numbers by means of less expensive fly cutter.

GEARS

Automobile, Machining. Cost-reducing Tooling Equipments, Ralph E. Flanders. Machinery (Lond.), vol. 19, no. 485, Jan. 12, 1922, pp. 441–444, 10 figs. Machines and tooling equipments used for performing turning, boring, facing, and recessing operations on automobile gears.

Tooling Equipment for Automobile Gears and Ball Races, Ralph E. Flanders. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 447–451, 14 figs. Describes jobs performed on Fay automatic lathes and operations on double-spindle flat turret lathes and Hartness automatic lathes.

Grinding Hardened Teeth. Grinding Hardened Gear Teeth. Eng. Production, vol. 4, no. 67, Jan. 12, 1922, pp. 42–44, 6 figs. Describes machine for finish grinding spur gear teeth to within definite limits of accuracy, and without producing scrap.

High-Carbon, Reclaiming. Reclaiming High Carbon Gears, R. L. Dowdell. Am. Soc. for Steel Treating Trans., vol. 2, no. 4, Jan. 1922, pp. 320–322, 8 figs. Describes method by which these gears could be reclaimed by heat treatment which would give them a tough core with a hard case by varying the internal structures without altering carbon content.

Involute. Gear Tooth Shapes, E. W. Miller. Am. Mach., vol. 56, nos. 4 and 5, Jan. 26 and Feb. 2, 1922, pp. 129–132 and 168–172, 26 figs. Study of fundamentals in principles of involute gearing in endeavor to find a suitable standard form and pressure angle.

The Evolution of the Involute Gear Tooth—XI, A. Fisher. Machy. (Lond.), vol. 19, no. 487, Jan. 26, 1922, pp. 513–517, 6 figs. Involute pitch and pressure-angle permutability.

Spur, Inspection of. Inspection of Spur Gears, D. Vaughn Waters. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 465–466, 4 figs. Describes practice of Gould & Eberhardt, Newark, N. J., in inspecting spur gears, with particular reference to uniformity of tooth spacing and concentricity of pitch circle relative to axis of gear.

Transmission. Transmission (Les Transmissions), Legrand-Ribet. L'Outillage, vol. 241, no. 1, Jan. 7, 1922, pp. 8–17, 44 figs. Discusses dimensions, speed of transmissions, bearings, brakes, pulleys, etc.

Variable-Speed. Gears and Mechanisms at Variable Speed (Les embrayages et les mécanismes en mouvement varié), H. Meuris. Annales des Travaux Publics de Belgique, vol. 22, Dec. 1921, pp. 993–1006, 4 figs. Distinguishes between those where starting and stopping occurs rarely, and where it occurs frequently, and studies useful work and lost work mathematically.

GRINDING MACHINES

Practice. Grinding Machines and Practice—II–VII. Mech. World, vols. 70 and 71, nos. 1812, 1816, 1819, 1821, 1824 and 1829, Sept. 23, Oct. 21, Nov. 11, 25, Dec. 16, 1921 and Jan. 20, 1922, pp. 238–239, 318–320, 378–379, 418–419, p. 478 and pp. 42–43, 32 figs. Sept. 23: Discusses grain and grade; bonds used for vitrified silicate, elastic and other wheels; and natural and artificial abrasives. Oct. 21: Selection of wheels for a given job; hardness; speeds; dressing and truing wheels; etc. Nov. 11 and 25: Design of wheel mountings. Dec. 16: Discusses the question of protection hoods and the production of sparks. Jan. 20: Cylindrical grinding machines, and wheel-spindle mounting for plain grinding machines. (To be continued.)

Wheel-Truing Attachment for Thread. Wheel-Truing Attachment for Screw-Thread Grinding. Engineering, vol. 113, no. 2925, Jan. 20, 1922, p. 76, 4 figs. on p. 78. Describes new attachment brought out by Precision & Thread Grinder Mfg. Co., Philadelphia, Pa., primarily intended for use with maker's multi-graduated precision thread grinder.

H

HARDNESS

Testing. Ball Hardness Testing of Semi-Steel (L'Essai de Dureté à la bille sur la Fonte aciérée), M. Portevin. Fonderie Moderne, no. 11, Nov. 1921, pp. 318–321, 2 figs. Establishes empiric formulas and gives advantages of Brinell test.

Hardness Testing (Beitrag zur Härteprüfung), F. Waizenegger. Forschungsarbeiten, no. 238, 1921, 32 pp., 13 figs. Notes on the Brinell test; effect of load, ball diameter and duration of load on coefficient hardness; calculation of maximum coefficient of hardness; comparison of different materials by means of maximum hardness coefficient. Tests of A. Kürth to determine relation between maximum hardness coefficient and (a) tensile strength, (b) yield point and (c) temperature.

Some Brinell Hardness Measurements on Small Specimens, E. D. Campbell. Am. Soc. for Steel Treating Trans., vol. 2, no. 4, Jan. 1922, pp. 269–273, 1 fig. Describes attachment for the standard Alpha Brinell machine which enables hardness measurments to be made on small bars with almost as much ease and accuracy as can be done on larger specimens.

HEAT TREATING

Electric. Economics of Electric Heat Treating, E. F. Collins. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 76–81, 5 figs. Method of electric heat transmission and delivery to charge; importance of insulation in various types of furnaces.

HEAT TRANSMISSION

Liquid to Liquid. Numerical Law of Heat Transmission Between Liquids in Industrial Heat Exchangers (Lois numériques de la Transmission de la Chaleur entre les fluides dans les Echangeurs Industriels), H. Dieterlen. Chaleur et Industrie, vol. 2, nos. 17, 18 and 19, Sept., Oct. and Nov. 1921, pp. 570–579, 649–652 and 736–746, 16 figs. Sept.: The coefficient of transmission through walls. Oct.: Formulas used. Nov.: Construction of economisers of the Kablitz type.

HEATING

Direct-Indirect. The Weak Spots in Direct-Indirect Heating, E. Vernon Hill. Heat. & Vent. Mag., vol. 19, no. 1, Jan. 1922, pp. 29–32, 5 figs. Results of test of air conditions in Greentown (Ind.) High School, made at request of Ind. State Board of Health, which has not approved use of direct-indirect heating systems.

HEATING, ELECTRIC

Residences. Electric Heating of Residences, Edgar Allan Loew. University Wash. Eng. Experiment Station Bul., no. 15, Dec. 1921, 44 pp., 8 figs. Experiments and reports on electric house heating. Experiences with domestic heating in Tacoma, Wash., and conclusions reached. Comparison of heating electrically and by means of coal; and possibilities in use of surplus, off-peak and seasonal power.

Thermal Processes. Electric Heat for Thermal Processes, E. F. Collins. Jl. Indus. & Eng. Chem., vol. 14, no. 2, Feb. 1922, pp. 101–104, 6 figs. Discusses heat generation and heat transmission, and gives examples of the various installations applying electric heat industrially.

HEATING, FACTORY

Analysis. An Analysis of Factory Heating, M. C. W. Tomilson. Factory, vol. 28, no. 2, Feb. 1922, pp. 162–164, 4 figs. Twelve ways to get more heat from less coal.

HELICOPTERS

Design. Theoretical Discussion of the Problem of Helicopters (Theoretische Bemerkungen zur Frage des Schraubenfliegers), Th. v. Kármán. Zeit. für Flutechnik u. Motorluftschiffahrt, vol. 12, no. 24, Dec. 31, 1921, pp. 345–354, 8 figs. Discusses the three theoretical problems governing design of helicopters. It is believed that difficulties encountered in construction of a serviceable helicopter are greater than is generally supposed, though not insurmountable. Modern types of helicopters are described by same author in same journal (pp. 360–361, 4 figs.)

HOISTS

Electric. Factors Affecting Installation of Electric Motors for Hoisting, Gordon Fox. Elec. World, vol. 79, no. 4, Jan. 28, 1922, pp. 171–173, 1 fig. Methods of determining size of motors required. Various types of skip hoists and their use. Advantages and disadvantages of a.c. and d.c. drives for skip hoists.

HYDROELECTRIC DEVELOPMENTS

Upper Rhone, France. Improvements in the Upper Rhone (L'Aménagement du Haut Rhône), Léon Perrier. Annales de l'Énergie, vol. 1, no. 2, Mar.–Apr. 1921, pp. 49–57, 1 fig. Technical data and principal projects for making use of water power and navigating the French Upper Rhone.

Western U. S. Projects. Some Western Hydroelectric Projects Under Way in 1921 or Definitely Scheduled for 1922. Jl. Electricity & Western Industry, vol. 48, no. 2, Jan. 15, 1922, pp. 60–61. List giving essential data in tabular form.

HYDROELECTRIC PLANTS

Barcelona, Spain. Power Transmission by the Catalan Gas and Electric Co. (La transmission d'énergie Seira-Barcelone de la Société catalane du Gaz et l'Électricité à Barcelone), J. Reyval. Revue Générale de l'Électricité, vol. 11, no. 1, Jan. 7, 1922, pp. 11–31, 31 figs. Describes control of water power, the hydroelectric plant and its equipment at Seira, transmission lines, substations, transformers, etc.

Bathurst, N. B. Hydro-Electric Developments Near Bathurst, N. B., James Dick. Can. Engr., vol. 42, no. 5, Jan. 31, 1922, pp. 181–185, 10 figs. Construction details of plant at Grand Falls, Nepisiguit River. 15 mi. of standard-gage railway laid to work. Power house and dam of reinforced concrete. Transmission line is 19 mi. long.

Design. Hydro-Electric Developments, W. M. White. Denki Gakkwai Zasshi (Jl. Inst. Elec. Engrs. Japan), no. 402, Jan. 1922, pp. 21–31, 6 figs. Deals with design of power house and dam, tunnels, canals, pipe lines, turbines, draft tubes and tail race.

Increasing Capacity. Increasing Capacity of Parnahyba Plant, H. P. Quick. Power, vol. 55, no. 5, Feb. 7, 1922, pp. 212–213, 3 figs. Describes how a hydroelectric plant in Brazil, originally laid out for 16,000 hp. was modified to develop double this capacity.

Pit River, California. The Pit River Hydroelectric Power Project, Charles W. Geiger. Power Plant Eng., vol. 26, no. 2, Jan. 15, 1922, pp. 105–111, 8 figs. Describes first two plants of Pacific Gas & Elec. Co. on its Pit River system in Shasta county where unusual geological formation makes possible operation of a system without necessity of artificial storage capacity.

Queenston-Chippawa. First Unit for Queenston-Chippawa Water Power Plant Opened. Eng. News-Rec., vol. 88, no. 3, Jan. 19, 1922, pp. 110–111. Includes views of completed hydroelectric development around Niagara Falls in Ontario.

South Africa. Description of the Hydroelectric Power Plant Installed at Howick Falls, H. W. Miller. So. African Instn. of Engrs. Jl., vol. 20, no. 4, Nov. 1921, pp. 62–71, 6 figs. Describes work connected with construction of concrete diversion weir, a pipe line of some 600 ft. in length with upper section 34 in. diameter by 200 ft. long, the power house and machinery, etc. See also So. African Eng., vol. 32, no. 12, Dec. 31, 1921, pp. 242–243.

Trash-Rack Rake. Mechanical Trash-Rack Rake. I. W. Jones. Power, vol. 55, no. 4, Jan. 24, 1922, pp. 131–132, 3 figs. Describes rack rake developed by author, consisting of motor-operated car mounted on wheels designed to travel on rails inlaid in rack platform. Rake is supported by light structural-steel framework and operated by four steel cables.

Wales. Hydro-Electric Installation at Denbigh Asylum. Engineer, vol. 133, no. 3446, Jan. 13, 1922, p. 50, 8 figs. Describes erection of dam 160 ft. long to give fall of 15 ft., a fish pass, and generating station in which are installed a water turbine, electric generator and switchgear.

HYDRAULIC TURBINES

Governors. Hydraulic Turbine Governors, W. R. Kepler. Elec. Jl., vol. 19, no. 2, Feb. 1922, pp. 60–68, 12 figs. Discusses limitation of speed to suit conditions demanded by character of load. Governing element may be grouped into three sections, (1) flyballs, valve and compensating device, (2) pressure system and (3) mechanism for applying energy of pressure system to change amount of water tarough turbine.

Kaplan. The Brake Horsepower Guarantees of the Kaplan Turbine Concern in the Storek Turbine Experimental Station in Brünn (Austria) (Die Garantiebremsungen des Kaplanturbinenkonzerns in der Turbinenversuchsanstalt der Firma Storek in Brünn), J. Slavik and P. Walther. Elektrotechnik u. Maschinenbau, vol. 40, no. 2, Jan. 8, 1922, pp. 13–15, 4 figs. Results of brake tests carried out under supervision of Dr. Kaplan and his assistants and members of Kaplan Turbine Concern, not only achieved, but greatly exceeded guaranteed efficiency.

I

ICE MANUFACTURE

Hoisting System. Economical Ice Harvesting, Otto Luhr. Ice & Refrigeration, vol. 62, no. 1, Jan. 1922, pp. 16–17. Describes a multiple ice-hoisting system, hoisting a whole row of cans at a time by putting cans in a framework and attaching air-agitating device onto framework so that only one air connection need be made. Paper read before Nat. Assn. Pratical Refrig. Engrs.

Refrigerating Process. Voorhees' Refrigerating Economics, Gardner T. Voorhees. Ice & Refrigeration, vol. 62, no. 1, Jan. 1922, p. 22, 2 figs. Discusses the

multiple-effect receiver, multiple-effect compressor, compressed exhaust-steam process, double-freezing can ice process, and the non-cracked ice and fore-cooler process. Paper read before Nat. Assn. Pratical Refrig. Engrs.

ILLUMINATION

Committee Reports. Illumination Items by the Lighting and Illumination Committee. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 2, Feb. 1922, pp. 149–151, 4 figs. Notes on preliminary report by P. W. Cobb on influence of illumination levels upon speed of vision; electric sign lighting; and report of Committee on Elimination of Waste in Industry of Am. Eng. Council on accidents due to eye defects.

IMPACT

Bars, Duration of. Duration of Impact of Bars, Erwin W. Tschudi. Physical Rev., vol. 18, no. 6, Dec. 1921, pp. 423–430, 4 figs. Experiments show that duration of impact is not a linear function of length of colliding bars, a fact directly contrary to compressional wave theory.

INDICATORS

Steam-Engine. The Steam-Engine Indicator Power, vol. 55, nos. 4, 5 and 6, Jan. 24, 31 and Feb. 7, 1922, pp. 142–144, 6 figs., 182–184, 10 figs. and 224, 3 figs. Jan. 24: What a reducing rig is and how it is made. Jan. 31: Reducing rigs on modern engines, and reducing wheels and cylinder connections. Feb. 7: Checking reducing rig for errors.

INDUSTRIAL MANAGEMENT

Job Analysis. Job Analysis as a Factor in Cost Reduction, Richard S. Uhrbrock. Indus. Management, vol. 63, no. 2, Feb. 1922, pp. 100–102. Qualifications of the analyst and methods of approach.

Overhead Distribution. Lightening the Factory Burden, Clinton W. Bennett. Indus. Management, vol. 63, no. 2, Feb. 1922, pp. 103–106, 5 figs. Distribution of overhead for analysis and control.

Production Control. Production Control by Graphics. Machinery (Lond.), vol. 19, no. 484, Jan. 5, 1922, pp. 405–412, 13 figs. Describes system employing graphic charts for controlling shop operations in plant making cotton looms and automatic attachments for looms.

Production Planning. Production Planning at the Dennison Plant. Factory, vol. 28, no. 2, Feb. 1922, pp. 159–162, 4 figs. Describes system which controls made-to-order goods almost entirely, where each order requires special attention. Its main object and accomplishment is to coördinate all departments to secure most satisfactory ultimate results.

Small Shop Overhead. Minimum Shop Operation Without Loss. D. S. Cole. Indus. Management, vol. 63, no. 2, Feb. 1922, pp. 96–97, 1 fig. Describes how small industrial plant operated plant during period of curtailed manufacturing operations, without allowing overhead or fixed expense to force losses.

[See also TIME STUDY.]

INDUSTRIAL ORGANIZATION

Drafting Rooms. The Organisation of a Jig and Tool Drawing Office, H. Varley. Eng. & Indus. Management, vol. 7, no. 5, Feb. 2, 1922, pp. 123–126, 4 figs. Development and scope of tool office; size of tool drawing office; duties of jig and tool office, relationship with productive departments; layout of office organization; and division of work.

Knitting Mills. The Organization of Knitting Mills Carle M. Bigelow. Management Eng., vol. 2, no. 2, Feb. 1922, pp. 111–116, 10 figs. Standardizing work of planning department.

INDUSTRIAL RELATIONS

Alliance of Employers and Employees. Association of Employers and Employees. Iron Age, vol. 109, no. 6, Feb. 9, 1922, p. 407. Unique institution in Cleveland in which better understanding is brought about. Educational and other features.

INJECTORS

Exhaust-Steam, Locomotive. An Improved Exhaust Injector For Locomotives. Ry. Engr., vol. 43, no. 504, Jan. 1922, pp. 9–10 and 12, 3 figs. Describes advantages of new F type injector made by Davies & Metcalfe, Romiley.

Metcalf's Exhaust Steam Injector. Engineering, vol. 113, no. 2925, Jan. 20, 1922, pp. 71–72, 4 figs. New pattern, constructed by Davies & Metcalfe, Ltd., Romiley, England, is capable of delivering water against pressure of 150 lb. per sq. in., with 1 lb. exhaust pressure, thus greatly reducing amount of live steam necessary to get up to normal working pressures in locomotive pratice.

INSTRUMENTS

Control. The Organization of Instrument Control in Industrial Plants, Frederick J. Schlink. Management Eng., vol. 2, no. 2, Feb. 1922, pp. 67–72, 4 figs. Deals with factors in instrument control and describes some typical installations. Qualifications and duties of inspectors. Calibration and tagging of instruments. Installation, repair and maintenance.

INTERNAL-COMBUSTION ENGINES

Lubricating Oils. Lubricating Oil, W. R. G. Atkins. Automobile Engr., vol. 11, no. 158, Dec. 1921, pp. 450–452. Factors affecting its consumption in internal-combustion engines.

Research. Recent Research Work on the Internal Combustion Engine, Harry R. Ricardo. Automotive Industries, vol. 46, no. 3, Jan. 19, 1922, pp. 126–133, 15 figs. Discusses effect of latent heat of vaporization, mean volatility, temperature, pressure, dilution, mixture strength, stratification and other factors upon combustion, and especially the detonation, of various fuels. Condensed from paper read before Soc. Automotive Engrs.

Semi-Ideal Gases for. Semi-Ideal Gases and Efficiency of Internal-Combustion Engines (Halbideale Gase und Wirkungsgrad der Verbrennungsmaschinen), M. Seiliger. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 1, Jan. 7, 1922, pp. 8–10, 1 fig. It is claimed that gases of internal-combustion engines are not ideal, but semi-ideal. Their adiabatics cannot be expressed by a polytropic curve. Equations of adiabatics and isodiabatics for semi-ideal gases are developed. Based on these equations and with regard to volume reduction and change of specific heat in combustion, the efficiency of a general working process is determined.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES.]

IRON

Charcoal, Manufacture of. Manufacture of Charcoal Iron and Charcoal Iron Boiler Tubes, W. H. S. Bateman. Southern & Southwestern Ry. Club, vol. 16, no. 6, Nov. 17, 1921, pp. 10–17 and (discussion) 17–21. Describes processes of manufacture and method of rolling skelp for tubes.

IRON ALLOYS

Silicon-Iron. Silico-Thermy and Its Practical Application, C. A. Heise. Iron Age, vol. 109, no. 5, Feb. 2, 1922, pp. 337–338, 5 figs. German iron-silicon castings of "thermisilid" made by thermal reactions. Silicides which are formed. Properties of new alloy. Paper read by Richard Walter before German Met. Soc.

IRON, PIG

Pig-Breaking Machine. A New Pig-Breaking Machine. Foundry Trade Jl., vol. 24, no. 289, Dec. 29, 1921, p. 519, 2 figs. Describes patent of E. Roper & Co., of Keighley, made either for belt or direct motor drive.

Synthetic. Recarburising Steel for Iron Foundry Use. Foundry Trade Jl., vol. 25, no. 282, Jan. 12, 1922, pp. 29–30. Describes series of trials made at Rombach, and gives analyses of cupola-melted steel scrap, billets and slags, also typical analyses of recarburized Bessemer steel and Bessemer steel recarburized with charcoal. From Stahl u. Eisen.

Synthetic Iron (Considérations sur les Fontes synthétiques), A. Keller. Fonderie Moderne, no. 11, Nov. 1921, pp. 327–336, 10 figs. Discusses process of making synthetic iron from scrap in the electric furnace, and its application for various purposes.

The Production of Synthetic Pig Iron By the Oehler & Cie. Iron & Steel Works, Inc., Aarau (Switzerland) [Ueber die Herstellung von synthetischem Roheisen bei den Eisen- und Stahlwerken Oehler & Cie., A.-G., Aarau (Schweiz)], K. Dornhecker. Stahl u. Eisen, vol. 41, no. 52, Dec. 29, 1921, pp. 1881–1889, 14 figs. partly on supp. plate. Notes on general aspects of production of pig iron from scrap and fundamentals of different processes; advantages of production in electric furnace with extensive carburization in the solid state. Details of the Aarau plant and planned enlargement.

L

LABORATORIES

Engineering Works. An Engineering Works Laboratory. Engineering, vol. 113, no. 2924, Jan. 13, 1922, pp. 34–36, 4 figs. Describes laboratory and equipment of W. H. Allen Sons & Co., Ltd., Bedford, England, manufacturers of high-speed engines, turbines, oil engines, electrical machinery, etc.

LATHES

Scroll-Forming. Lathe Formers, V. Gartside. Machy. (Lond.), vol. 19, no. 487, Jan. 26, 1922, pp. 505–507, 7 figs. Discusses scroll-turning lathes.

Turret. Turret Lathe Tooling. Machy. (Lond.), vol. 19, no. 487, Jan. 26, 1922, pp. 500–501, 4 figs. Equipment for machining differential gear housings on turret lathes.

Wheel. A New 48-In. Wheel Lathe. Ry. Gaz., vol. 35, no. 22, Nov. 25, 1921, pp. 815–816, 2 figs. Describes a modern wheel lathe characterized by abundance of driving power, rigidity, efficient operating facilities, and high output, made by Noble & Lund, Ltd., Felling-on-Tyne.

LEATHER INDUSTRY

Research. Research in Leather Manufacture, Arthur W. Thomas. Mech. Eng., vol. 44, no. 2, Feb. 1922, p. 116. Describes work which has been done and points out that there is a great field in tanning industry, by prosecution of scientific research, to eliminate unnecessary wastes due to lack of knowledge of reactions.

LIGHTHOUSES

Aerial. Aerial Lighthouses. Flight, vol. 14, no. 4, Jan. 26, 1922, pp. 52–54, 3 figs. Describes the 1,000,000,000-c.p. lighthouse which is being erected at Dijon for aerial routes between Paris and Algiers, Italy and Switzerland, made by Barbier, Bernard and Turenne, of Paris.

LIQUIDS

Emulsified, Pumping. Pumping Liquids and Light Bodies by Emulsifying (Pompage des liquides et des corps légers par émulsion), Henry Béduwé. Révue Universelle des Mines, vol. 11, nos. 1 and 2, Oct. 1 and 15, 1921, pp. 57–64 and 155–160, 7 figs. Oct. 1 Describes application and operation of air lift pump, and expetiments made by Westinghouse Air Brake Co. Oct. 15 Discusses industrial applications of emulsion pump, pumping by compressed air, etc.

LOCOMOTIVE BOILERS

Pulverized-Coal-Fired. Pioneer Boilers fired With Pulverized Coal, F. P. Coffin. Combustion, vol. 6, no. 2, Feb. 1922, pp. 74–77 and 95, 2 figs. Describes the Bettington boiler, designed for firing with powdered coal or coal dust; the Erie City Iron Works boiler, designed by Aero Pulverizer Co; and the American Locomotive Works boiler. (Abstract.)

Tube Fractures. Notes on Fractures in Locomotive Boiler Tubes, Henry Fowler. Faraday Soc. Trans., vol. 17, part 1, no. 49; Dec. 1921, pp. 82–90, 11 figs. Results of investigation of large tubes of boiler on Midland Railway showing brittleness and fractures.

LOCOMOTIVES

Adhesion and Rack. Adhesion and Rack Locomotive for Sumatra, S. Abt. Ry. Age, vol. 72, no. 4, Jan. 28, 1922, pp. 263–266, 7 figs. Describes 0-10-0 type superheater four-cylinder compound locomotive of Dutch State Railways; tractive effort 30,865 lb.

British Types, 1921. Locomotives in 1921. Engineer, vol. 133, no. 3445, Jan. 6, 1922, pp. 10–12, 17 figs. partly on supp. plates and p. 14. Data on locomotives built for different British roads.

Electric. See ELECTRIC LOCOMOTIVES.

Fireless. The Explosion of a Fireless Locomotive in the German Works in Dachau (Zerknall einer feuerlosen Lokomotive in den Deutschen Werken in Dachau). Zeit des Bayerischen Revisions-Vereins, vol. 25, nos. 23 and 24, Dec. 15 and 31, 1921, pp. 191–193 and 200–204, 14 figs. Account of explosion of locomotive for operating pressure of 13 atmos., equipped with simple cylindrical, 4-meter-long steam boiler with diam. of 1690 mm. Results of investigation lead to conclusions that explosion was due to disadvantageous shape of boiler head; inferior quality of boiler plate; and to deficient heat treatment in construction of head.

Freight. Geared Locomotive for Freight Service. Ry. Jl., vol. 28, no. 2, Feb. 1922, p. 12, 1 fig. Particulars of 150-ton Shay geared three-truck type locomotive for freight service in mountainous regions. Tractive power, 59,740 lb. Built by Lima Locomotive Works, Inc., for Greenbriar, Cheat & Elk Railroad.

Gasoline. A Practical and Powerful Gasoline Switch Locomotive, L. C. Josephs, Jr. Ry. Rev., vol. 70, no. 3, Jan. 21, 1922, pp. 82–84, 4 figs. Describes the Mack gasoline locomotive by which smoke and fire risks are eliminated.

New Castle Mfg. Co. The New Castle Manufacturing Company, J. Snowden Bell. Ry. & Locomotive Eng., vol. 35, no. 1, Jan. 1922, pp. 1–4, 3 figs. Describes first locomotive built by Stephenson and locomotive "America" built by New Castle Mfg. Co.

Rebuilt. Rebuilt Locomotives, London & South Western Railway. Ry. Gaz., vol. 36, no. 1, Jan. 6, 1922, pp. 21–23, 6 figs. By rebuilding, tractive effort is raised fro n 21,620 to 23,500 lb. for freight engines, and from 16,900 to 20,240 lb. for tank engines.

Stokers. An Everyday Run With the New Hanna Type H-2 Stoker. Ry. Rev., vol. 70, no. 2, Jan. 14, 1922, pp. 51–53, 2 figs. Describes performance on Norfolk & Western mountain-type locomotive; tractive effort, 57,200 lb.

Three-Cylinder. Three-Cylinder Locomotive for Spanish Railways. Engineer, vol. 133, no. 3449, Feb. 3, 1922, pp. 134–136, 8 figs. partly on supp. plate. Describes 8-coupled locomotive of 4-8-0 type, with double bogie tender, built by Yorkshire Engine Co., Ltd., Sheffield, England. Gives characteristics of engine and tender.

Truck Arrangement. On the Question of Bogies (Trucks), Axles and Springs of Locomotives, M. Bochet. Int. Ry. Assn. Bul., vol. 4, no. 1, Jan. 1922, pp. 193–250, 20 figs. Report No. 2 (All countries, except those using English language, Belgium and Scandinavian countries). Best arrangement of truck, axles and springs of locomotive for high speeds, with long wheelbases, so as to facilitate running round curves and to insure proper stability of engines.

LUBRICATING OILS

Treatment of Distillates. The Treatment of Refined Oil Distillate, C. D. Dean. Can. Machy., vol. 27, no. 5, Feb. 2, 1922, pp. 42–44 and 46. Removing wax by cooling; treating lubricating oils; pitches and paving asphalts; distillation under pressure; storage, etc.

M

MACHINE DESIGN

Kinematics; Use in. Graphic Kinematics in Machine-Tool Design (Zeichnende Kinematik im Werkzeugmaschinenbau), Ferdinand Wittenbauer. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 2 and 3, Jan. 14 and 21, 1922, pp. 25–30 and 60–62, 45 figs. Notes on transmission and gears used in machine-tool construction; speed and acceleration of crank gear; slotting machines with quick return of tool; guidance of needles in Wanzer sewing machine; carriage guide for turning pulleys; drive of a high-speed planing machine; oscillating drives by eccentric wheels; oscillating motion of a slot-mortising machine; crank gear with quick-return stroke; oscillating crank guide; steel spring hammers, etc.

MACHINE SHOPS

British. Famous British Works. Eng. Production, vol. 4, nos. 67 and 69, Jan. 12 and 26, 1922, pp.

26-28, 5 figs., and 74-76, 6 figs. Jan. 12: Describes works of Fielding & Platt, Ltd., Gloucester, for manufacture of hydraulic machinery and gas and oil engines. Jan. 26: Works of Geo. Richards & Co., Ltd., near Manchester.

Department Layout. Department Layout in the Colburn Shop, Fred H. Colvin. Am. Mach., vol. 56, No. 7, Feb. 16, 1922, pp. 259–261, 12 figs. Arrangements for machining, erecting, and testing units and complete machines. Toolroom arrangement and heat-treating department. Lavatory and coatroom.

MACHINE TOOLS

Economical Drives. Efficiency and Fuel Consumption of Factory Installations (Wirkungsgrad und Brennstoffverbrauch von Fabrikanlagen), Karl Meller. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 46, Nov. 18, pp. 369–372, 8 figs. Investigation of efficiency of existing installations and how it can be improved with view to saving of coal.

MACHINES

Running Speed and Efficiency. Effect of Acceleration of Running Speed on Increase of Output in Factory Machines (Einfluss der Laufgeschwindigkeit auf die Leistungsteigerung bei Fabrikationsmaschinen), S. Ledermann. Werkstattstechnik, vol. 16, no. 1, Jan. 1, 1922, pp. 3–4, 2 figs. It is shown that acceleration of speed of machines does not always bring about an increase in performance, but that it is necessary to determine the work-time factor.

MAGNESIUM ALLOYS

Electron Metal. Elektron Metal, Adolph Bregman. Metal Industry (N. Y.), vol. 20, no. 1, Jan. 1922, pp. 1–5, 9 figs. Discusses composition; physical, chemical and electrical characteristics; fabrication, working, soldering and welding; melting and casting, principal uses; advantages and disadvantages.

MAGNETOS

Elements. The Functioning of Magnetos (Contribution à l'étude du fonctionnement des magnetos d'allumage), L. Canaby. Arts et Métiers, vol. 74, no. 12, Sept. 1921, pp. 273–281, 13 figs. Discusses the various elements and their influence on working of magneto; gives formulas and curves.

MARINE BOILERS

Economical Operation. Coal Economy at Sea by Improved Methods of Steam Generation, David Brownlie. Shipbuilder, vol. 26, no. 137, 1922 (New Year Number), pp. 49–54, 5 figs. Performance of stationary and marine boiler plants; coal weighing; boiler feedwater meters; saving effected by continuous analysis of flue gases.

MECHANICS

Modern Theories. Modern Theories in Mechanics (Les théories modernes de la mécanique), F. Blondel. Révue de l'Industrie Minérale, no. 25, Jan. 1, 1922, pp. 1–21, 12 figs. Discusses Einstein's theory of relativity and experiments leading up to it.

Present Crisis. The Present Crisis in Mechanics (Ueber die gegenwärtige Krise der Mechanik), R. v. Mises. Zeit. für angewandte Mathematik u. Mechanik, vol. 1, no. 6, Dec. 1921, pp. 425–431. Notes on mechanics of the relativity theory. Development of main problem, namely: Can it be assumed that all the phenomena of motion and equilibrium observable in visible bodies can be explained by the Newton and related laws? Development of a scheme of mechanical statistics.

Rigid Frames, Calculation of. Simplified Calculation of Rigid Frames, H. Marx. Mech. Eng., vol. 44, no. 2, Feb. 1922, p. 125, 1 fig. Describes new process devised by H. Bronneck for calculating most complicated frame shapes directly and without use of tables. Translated from Dinglers Polytechnisches Jl., vol. 336, no. 21, Oct. 22, 1921, pp. 301–302, 2 figs.

METALS

Cleaning. Industrial Methods of Metal Cleaning, F. MacDonald. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 66–70, 6 figs. Cleaning material; equipment for cleaning metal parts; methods.

Failure under Stress. Chemical Influences in the Failure of Metals under Stress, Cecil H. Desch. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 17–21: Investigation of such instances of intercrystalline rupture as may be attributed to action of chemical reagents.

The Mechanism of Failure of Metals from Internal Stress, W. H. Hatfield. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 36–46, 7 figs. Discusses influence of cold work, and chemical and corrosive attack. Notes on relative properties of amorphous and crystalline phases of metals, dealing with physical properties (hardness, elasticity, and capacity for plastic deformation) and chemical properties.

Fatigue Failure. Remarks on Fatigue Failure of Metal Parts, their Cause and Prevention, Horace C. Knerr. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 40–42, 4 figs. Factors upon which fatigue failure depends are: Number or repetitions; range of stress; presence of points at which stress may be localized. Gives example of fatigue failure.

Hardening. The Slip Interference Theory of the Hardening of Metals, Zay Jefferies and R. S. Archer. Chem. & Met. Eng., vol. 26, no. 6, Feb. 8, 1922, pp. 249–252. General reply to questions raised by various commentators, including condition of iron and carbon in and grain size of martensite.

Internal Stresses. Internal Stresses in Relation to Microstructure, J. C. W. Humfrey. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 47–51, 3 figs. Author offers suggestions, and draws attention to factor in strength of materials which does not appear adequately to have been studied.

Polishing. Motion Study in Metal Polishing. Metal Industry (Lond.), vol. 20, no. 2, Jan. 13, 1922, pp. 30–33, 3 figs. Describes experiment with a watt-meter on the process of roughing.

Season Cracking. The Failure of Metals under Internal and Prolonged Stress, W. Rosenhain. Faraday Soc. Trans., vol. 17, part 1, no. 49, Dec. 1921, pp. 2–16, 2 figs. Discussion of phenomenon known as season cracking, and consideration of the various explanations therefor.

METRIC SYSTEM

English or Mixed. English, Metric or a Mixed Measurement System. Machinery (Lond.), vol. 19, no. 484, Jan. 5, 1922, pp. 428–430. Considers relative values of each system in various aspects.

MOLDING MACHINES

Air and Electric. Develops Air and Electric Machine. Foundry, vol. 50, no. 2, Jan. 15, 1922, pp. 75–76, 1 fig. Air used for ramming sand into molds; but electricity has been adapted for rolling flask and afterward drawing pattern.

Design. The Present Status of Molding-Machine Construction (Der heutige Stand des Formmaschinenbaues), U. Lohse. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 1, Jan. 7, 1922, pp. 4–7, 12 figs. Deals with power molding machines, including molding presses and hydraulic molding machines.

Equipment and Use. Molding Machine Practice Is Successful, Paul R. Ramp. Iron Age, vol. 109, nos. 6 and 7, Feb. 9 and 16, 1922, pp. 397–399 and 462–464, 13 figs. Points out that even without castings recurring in large numbers, method may be made to pay. Details of equipment and its use. Marked gain in efficiency in making cylinder and piston molds.

Improvements. Recent Progress in Machine Molding (Neuere Fortschritte in der Maschinenformerei), U. Lohse. Giesserei-Zeitung, vol. 19, nos. 1 and 2, Jan. 3 and 10, 1922, pp. 8–12 and 29–32, 9 figs. Describes new arrangements and methods which tend to increase economy of machine molding.

Jarring. Jarring Molding Machines (Étude sur les Machines à mouler à secousses), M. Grospierre. Fonderie Moderne, no. 11, Nov. 1921, pp. 309–316, 5 figs. Discusses principles of machine and describes the Thomas electrically controlled machine working on gravity-magnetic principle. Discussion of paper by M. Ronceray, pp. 316–318.

MOLDING METHODS

Gray-Iron Castings. Mold Intricate Gray-Iron Castings, H. E. Diller. Foundry, vol. 50, no. 2, Jan. 15, 1922, pp. 45–51, 11 figs. Describes methods used for molding gas-meter castings and automobile parts, such as flywheels, transmission housings and piston rings.

MOTOR BUSES

Connecticut. The Bus is Finding Its Sphere in Connecticut. Elec. Ry. Jl. (Bus Transportation Section), vol. 59, no. 2, Jan. 14, 1922, pp. 5–13, 2 figs. Gives statistical summary of bus transportation services in state of Connecticut.

Design. Motor Bus and Its Relation to Electric Railways, Ralph M. Sparks. Elec. Ry. Jl. (Bus Transportation Section), vol. 59, no. 2, Jan. 14, 1922, pp. 36–38. Discusses design of motor buses so as to give reliability of service and comfort to passengers, low maintenance cost, and high operating efficiency.

Some Factors Which Must Be Considered in Bus Transportation, Ezra W. Clark. Elec. Ry. Jl. (Bus Transportation Section), vol. 59, no. 2, Jan. 14, 1922, pp. 14–16, 4 figs. Discusses future of bus and its proper design for safety, comfort and efficiency, from standpoints of manufacturing and operating.

Development. Evolution of the Motor Vehicle for Goods and Passenger Service, Percy Frost Smith. Inst. of Transport Jl., vol. 3, no. 1, Nov. 1921, pp. 35–44 and (discussion) pp. 44–47. History of development, and discussion of four principal types, namely, battery, steam, petrol gear-driven and petrol-electric transmission vehicles.

Double-Deck. Details of Equipment and Cost of Operation of Double-Deck Buses in Chicago. Elec. Ry. Jl. (Bus Transportation Section), vol. 59, no. 2, Jan. 14, 1922, pp. 31–36, 11 figs. Describes bus of Chicago Motor Bus Co.; seating capacity, 60; inclosed upper deck.

Overhauling Depot. An Omnibus Overhauling Depot. Engineer, vol. 133, no. 3449, Feb. 3, 1922, pp. 121–124, 19 figs. partly on pp. 130 and 137. Details of large works recently erected by London Gen. Omnibus Co., Ltd., with object of concentrating work of overhauling its vast fleet of motor buses in one building. At least 15 omnibuses are pulled to pieces and re-erected daily. See also Engineering, vol. 113, no. 2927, Feb. 3, 1922, pp. 145–147, 5 figs. partly on p. 140.

MOTOR PLOWS

German Types. Tendencies in German Motor-Plow Construction (Die auf der DLG-Ausstellung sichtbaren Richtlinien des Motorpflugbaues), H. Martiny. Wirtschaftsmotor, nos. 8 and 9, Aug. 10 and Sept. 10, 1921, pp. 29–32 and 31–35, 13 figs. Notes on development and progress, based on observations at exhibition of German Agricultural Soc.

MOTOR TRUCKS

Berliet Chassis. The 25-30 cwt. Berliet Chassis. Motor Transport, vol. 34, no. 880, Jan. 9, 1922, pp. 45–47, 7 figs. Describes French machine designed for heavy work on pneumatic tires which successfully passed very severe French army tests; horsepower rating, 20.1 on R. A. C. formula.

Buying Parts. Buying Parts for a Big Fleet—How a Big Company Economizes. Commercial Vehicle, vol. 26, no. 1, Feb. 1, 1922, pp. 8–9, 3 figs. Describes organization of Consumers Co. of Chicago, which has recently acquired equipment of Cook County Supply Co. and its ten subsidiary organizations.

German. The German Motor-Truck Industry (Die deutsche Kraft-Nutzfahrzeug-Industrie). Wirtschaftsmotor, no. 8, Aug. 10, 1921, pp. 6–19, 47 figs. Status and development of German and Austrian motor-truck construction. Details and illustrations are given of numerous types of trucks and buses.

Parts Design. Features of Recent Development in Truck Parts Design, P. M. Heldt. Automotive Industries, vol. 46, no. 1, Jan. 5, 1922, pp. 12–18, 12 figs. Discusses recent developments in engine, clutch, transmission, universal joint, rear axle and wheel design.

Six-Wheeled. Flexible Six-wheelers. Motor Transport, vol. 34, no. 882, Jan. 23, 1922, pp. 95–97, 14 figs. Underlying principles of these vehicles, the different types available, and their advantages and possibilities.

MOTORCYCLES

German Types. German Motor Cycles (Deutsche Krafträder und Einbaumotoren), Kurt Bernhard. Wirtschaftsmotor, no. 9a, Sept. 25, 1921, pp. 6–44, 61 figs. Details of numerous types, including high-power motor cycles with side carriages; medium- and low-power motor cylces; motor scooters; motor cycles with small non-detachable motors; and non-detachable motors.

N

NICKEL STEEL

Determination of Nickel. The Determination of Nickel in Steel (Nickelbestimmung in verschiedenen Stahlsorten), Hans Rubricius. Chemiker-Zeitung, vol. 46, no. 3, Jan. 7, 1922, p. 26. As result of numerous tests with steels of varying nickel content, it is shown that a complete precipitation of nickel from the ammonia solution can be effected with alcoholic dimethylglyoxim liquid.

Low-Carbon and Chromium. Low-Carbon Nickel and Nickel-Chromium Steels. Iron & Coal Trades Rev., vol. 104, no. 2812, Jan. 20, 1922, p. 77. Summaries of paper on the constitution and properties of low-carbon nickel steels, by J. N. Greenwood, and paper on nickel-chromium steels, by J. S. Dickenson.

O

OIL ENGINES

Solid-Injection. The Solid Injection Oil Engine, C. McTaminey. Mar. Eng. of Can., vol. 12, no. 1, Jan. 1922, pp. 11–14. Describes experiments made on oil tank of the Trefoil, main engines of which are of the four-stroke cross-head type.

OIL FUELS

Ceramic Kilns. Using Liquid Fuel in the Hoffmann Furnaces (L'Emploi des combustibles liquides dans les fours Hoffmann), L. Mascard. Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 133, no. 9, Nov. 1921, pp. 1192–1195, 2 figs. Discusses application of heavy oils and tars in ceramic furnaces.

Heavy Oils. Receiving Heavy Fuel Oils (Reception des combustibles liquids lourds), M. Denier. Bulletin Technique du Bureau Veritas, vol. 3, nos. 8, 9, and 10, Aug., Sept. and Oct. 1921, pp. 194–199, 221–227 and 245–251, 28 figs. Aug.: Discusses difficulties of "taking delivery" of mazout, etc., due to various methods of analysis and to its varying composition. Sept.: Discusses laboratory tests, specific gravity, water content, impurities, acidity, cold test flash point, fire point, etc. Oct.: Describes processes and apparatus for various tests, including ignition point, fluidity and viscosity.

OIL PUMPS

Quimby Screw. The Quimby Screw Pump. Ship bldg. & Shipg. Rec., vol. 19, no. 3, Jan. 19, 1922, p. 73. Data on this pump which has been employed in the American naval service as a high-pressure fuel-oil service pump.

OPEN-HEARTH FURNACES

Gun-Steel Manufacture. Acid Open-hearth Process for Manufacture of Gun Steels and Fine Steels. W. P. Barba and Henry M. Howe. Am. Inst. Min. & Metallurgical Engrs. Trans., no. 1114-S, 1922. 39 pp., 8 figs., and (in abstract) Min. & Metallurgy, no. 181, Jan. 1922, pp. 32–34. Report of committee appointed during war by Engineering Division of Nat. Research Council to study steel melting and ingot production for guidance of wartime manufacturers. Precautions are given for making the ingots of proper and uniform composition; of proper macro- and micro-structure; sound, that is, free from pipes, blowholes, cracks and roughness; and to prolong life of furnace.

Talbot. The Talbot Process in Comparison with Other Open-Hearth Processes (Das Talbotverfahren im Vergleich mit anderen Herdfrischverfahren), J. Puppe. Stahl u. Eisen, vol. 42, nos. 1 and 2, Jan. 5 and 12, 1922, pp. 1–10 and 46–54, 9 figs. Describes steel works, gas-producer and mixing plants in Witkowitz. Operating conditions of Talbot, Wellmann and ordinary open-hearth furnaces. Technical and economic results obtained with processes carried out in these three furnace types.

OXY-ACETYLENE CUTTING

Cutting Machines. The Godfrey Universal Oxygen-Jet Cutting Machine. Automobile Engr., vol. 11, no. 158, Dec. 1921, pp. 446–447, 4 figs. Built by Godfrey Eng. Works, Lond. Design and operation. Special attention has been given to blowpipe.

OXY-ACETYLENE WELDING

Pipe. Autogenous Pipe Welding. H. B. Iglehart. Power, vol. 55, no. 5, Jan. 31, 1922, pp. 173–174, 4 figs. Account of pratical demonstrations of welded pipe joints made under direction of writer at W. K. Mitchell Co. shops. (Abstract.) Paper read before Int. Acetylene Assn.

Rods for. Welding Rods for Oxy-Acetylene Welding. J. R. Dawson. Iron Age, vol. 109, no. 7, Feb. 16, 1922, pp. 468–472, 17 figs. Also Welding Engr., (vol. 7, no. 1, Jan. 1922, pp. 32, 37 and 40, 17 figs.) under title: Oxy-Acetylene Welding Rods. Their selection and composition as factor in successful results on steel. Welding cast iron. Copper and brass welding. Paper before International Acetylene Assn.

P

PACKING

Transit and Storage. Packing and Wrapping-Up for Transit and Storage (including Baling). Abridgments of Specifications, Period—A.D. 1909–15, class 94 (i), 1921, 221 pp. Patents for inventions.

PAPER MANUFACTURE

Chemical Hydration of Pulp. Chemical Hydration of Pulp, Alfred MacKay. Paper, vol. 29, no. 16, Dec. 21, 1921, pp. 7–10. Discusses hydration of stock by chemical treatment to replace hydration by beating, and gives results of tests carried out showing advatages of chemical hydration.

Fibers for. New Sources of Paper Fibers. Paper, vol. 29, no. 15, Dec. 14, 1921, pp. 20–23. Describes possibilities afforded by giant grasses of India and Africa.

Nigerian Grasses for Paper Making. Imperial Inst. Bul., vol. 19, no. 3, 1921, pp. 271–282. Account of investigation of two series of dried grasses, belonging to ten different species, received by Imperial Inst. from Nigeria in order that their suitability for manufacture of paper might be ascertained.

Laid and Wove Molds. Laid and Wove, Dard Hunter. Paper, vol. 29, no. 16, Dec. 21, 1921, pp. 12–18, 7 figs. Origin of the terms described and their early use set forth.

PAPER MILLS

Construction. Paper Mill Construction, H. S. Taylor. Paper, vol. 29, no. 15, Dec. 14, 1921, pp. 9–11. Discusses engineering as related to pulp and paper industry, plant development, efficiency in operations, organization, etc.

PIPE, STEEL

Centrifugally Cast. Steel Pipe by the Centrifugal Process, L. Cammen. Iron Age, vol. 109, no. 6, Feb. 9, 1922, pp. 405–406. Methods and cost of Cammen process for making seamless pipe at low cost. Competition with welded pipe.

PIPE, WOOD-STAVE

Redwood vs. Fir. Wood-Stave Water Pipe. Pub. Works, vol. 52, no. 1, Jan. 7, 1922, p. 5. Summary of results obtained by its use in U. S. Reclamation projects during past 20 years. Comparison of fir and redwood, buried and above ground.

60-in. Pipe Line. 60-Inch Wood Stave Pipe Line for Hydroelectric Plant, W. A. Scott. Eng. World, vol. 20, no. 2, Feb. 1922, pp. 69–70, 2 figs. New pipe line, 912 ft. long, was built upon a regraded bed and is supported by 166 concrete cradles, each 6 in. thick above ground, with concrete bases 12 in. thick. Staves were creosoted by vacuum process.

POWER PLANTS

Remodeling. Remodeled Naval Proving Grounds Power Plant, P. J. Searles. Power, vol. 55, no. 4, Jan. 24, 1922, pp. 133–134, 2 figs. Describes changes that were made, and gives total cost figures for new boiler, stoker, generator, electrical and auxiliary equipment, etc. Plant was kept in operation while work of remodeling was going on. Explains how difficulty arising in supporting steam pipes was overcome.

POWER TRANSMISSION

Friction Losses. The Problem of Efficient Power Transmission, G. C. V. Hewson. Can. Machy., vol. 27, no. 3, Jan. 19, 1922, pp. 23–26, 8 figs. Friction causes largest percentage of loss; charts and tables showing different conditions.

Industrial Plants. Power Transmission in Industrial Plants, Kenneth M. Raynor. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 1, Jan. 1922, pp. 1–10 and (discussion) 10–21, 5 figs. Discusses construction, operation and some operating results obtained from a 6600-volt, 25-cycle, three-phase balanced-current overhead power transmission loop system operating in a modern steel-mill plant.

PRESSES

Punch, Guard for. Eliminating Cold Trim Press Accidents, G. A. Kuechenmeister. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 71–72, 2 figs. After experimenting with various kinds of "two-handed" mechanical tripping devices an electrical guard was installed. Production has not suffered and accidents are eliminated.

Lignite, Preparation of. The Pulverization of Rhenish Lignite (Die Aufbereitung rheinischer Braunkohle zu Staub), H. Weiss and H. Haering. Braunkohle, vol. 20, no. 40, Jan. 7, 1922, pp. 625–631, 4 figs. Describes drying and pulverizing process of the Büttner Works, Inc., Uerdingen on the Rhine; and use of pulverized coal for heating of a recuperative furnace.

Preparing and Distributing System. Preparing and Distributing Powdered Coal, E. C. Greisen. Iron Age, vol. 109, no. 5, Feb. 2, 1922, pp. 326–329, 8 figs. Modern seamless steel-tube plant adopts pulverized coal as fuel. Details of system in use for furnaces and boilers.

PUMPS

Boiler-Feed, Governor for. Thermofeed Differential Feed-Pump Governor. Power, vol. 55, no. 5, Jan. 31, 1922, pp. 184–185, 4 figs. Describes device which, when attached to steam supply of pump, will not only cause pump to stop when any predetermined pressure has been attained, but will start pump again as soon as any predetermined drop in pressure has taken place in feed pipe.

PUMPS, CENTRIFUGAL

Corrosive Liquids. The Flexala and Resilene Pumps. Engineering, vol. 113, no. 2925, Jan. 20, 1922, pp. 74–75, 8 figs. Describes centrifugal pumps manufactured by Metal Powders, Ltd., London, feature of which is a flexibility and resilience in certain parts which tend to reduce erosion and corrosion when dealing with acids or liquids holding solids or fibrous matters in suspension.

High- and Low-Lift. The Applications of High- and Low-Lift Centrifugal Pumps. Mech. World, vol. 71, nos. 1829 and 1830, Jan. 20 and 27, 1922, pp. 46–48 and 67–68, 9 figs. Jan. 20: Characteristics of a centrifugal pump; advantages of centrifugal over reciprocating type. Describes De Laval single-stage centrifugal pump having capacity of 10,000 gal. per min. against 150 ft. head. Jan. 27: Discusses boiler feeding and electrically driven centrifugal boiler-feed pumps; circulating pumps for surface condensers barometric and jet condensers.

PYROMETERS

Maintenance Costs. Maintenance Costs of Pyrometric Systems, R. W. Newcomb and G. V. Nightingale. Forging & Heat Treating, vol. 8, no. 1, Jan. 1922, pp. 50–51. Lack of appreciation of sensitivity of pyrometric instruments; thermocouples as high factor in maintenance cost; better protection tubes and care in selection.

Radiation. A New Radiation Pyrometer (Ein neues Strahlungspyrometer). Chemiker-Zeitung, vol. 46, no. 2, Jan. 5, 1922, pp. 20–21, 2 figs. Describes new pyrometer in the shape of a small telescope for use of works engineer in measurement of furnace temperature.

Thermoelectric and Optical. Electrical Instruments for Industrial Measurements, Ezer Griffiths. Beama, vol. 10, no. 1, Jan. 1922, pp. 18–27, 9 figs. Thermoelectric pyrometry and optical pyrometry. Discusses temperature indicators of millivoltmeter type; recording pyrometers; recording potentiometer; automatic temperature control; disappearing filament-type optical pyrometer; and laboratory standard optical pyrometer.

R

RAILS

Basic Bessemer Steel. Basic Bessemer Steel Rails, Cecil J. Allen. Ry. Engr., vol. 43, no. 504, Jan. 1922, pp. 5–8 and 35, 2 figs. Details of modern methods employed in Europe in production of rails by basic bessemer process, including reaction in basic converter, graphic method of estimating additions, comparison of analysis and test results, reliability of basic bessemer steel.

Corrugation. The Corrugation of Tramway Rails. Engineer, vol. 133, no. 3447, Jan. 20, 1922, p. 66, 1 fig. Abstract of report presented to Mun. Tramways Assn. by Rail Corrugation Sub-committee appointed to investigate corrugation of tramway rails, with particular reference to vibration of rails and foundations as cause thereof.

Girder, Rolling. Rolling Girder Rails, R. C. Cram. Elec. Ry. Jl., vol. 59, no. 3, Jan. 21, 1922, pp. 102–106, 16 figs. Describes the various rolling-mill processes incidental to rolling girder rails; essential difference in rolling T-rails and girder rails; recent developments.

Joint Welding. Reclaiming Joints in Indianapolis, T. H. David. Elec. Ry. Jl., vol. 59, no. 5, Feb. 4, 1922, pp. 199–201. Discusses experience with Lorain weld joints, arc welding on old tracks, and thermit welding. (Abstract.) Paper read before Central Elec. Ry. Assn.

Manufacture. Improvement in the Manufacture of Rails. Ry. & Locomotive Eng., vol. 35, no. 1, Jan. 1922, pp. 6–7. Describes tests made with Hadfield sink-head ingots rolled by Maryland Steel Co., showing that after removal of top discard of 13 per cent, the Hadfield ingot is free from piping and undue segregation.

Standard 7-in. Standard Rails Reduce Costs, R. C. Cram. Aera, vol. 10, no. 7, Feb. 1922, pp. 581–583, 2 figs. Advocates use of Association standard seven-inch girder grooved rail.

RAILWAY CONSTRUCTION

Program. Real Program of Railroad Construction Needed, Herbert Hoover. Ry. Age, vol. 72, no. 6, Feb. 11, 1922, pp. 379–382. Tremendous losses suffered because of lack of foresight and antagonism to railroads.

RAILWAY ELECTRIFICATION

England. The Electrification of English Main Line Railways. Engineering, vol. 113, no. 2926, Jan. 27, 1922, pp. 102–104. Account of discussion held at joint meeting of Instn. Mech. Engrs., Instn. Civ. Engrs. and Instn. Elect. Engrs.

St. Gothard Ry., Switzerland. The Electrification of the St. Gothard Railway. Engineer, vol. 133, no. 3447, Jan. 20, 1922, pp. 68–70, 15 figs. partly on p. 72. Details of electrical equipment of Ritom and Amsteg power stations, locomotive types, etc.

RAILWAY MOTOR CARS

New Haven Branch Lines. New Haven Using Motor Cars on Branch Lines. Ry. Age, vol. 72, no. 5, Feb. 4, 1922, pp. 315–317, 4 figs. Advantages of new passenger-equipment car, including flexibility and low operating cost.

RAILWAY OPERATION

British Railway Speeds. Tables of British Railway Speeds in 1921. Engineer, vol. 133, no. 3449, Feb. 3, 1922, pp. 120–121. Annual statistics.

Train Control. The Control of Trains. Ry. Gaz., vol. 36, no. 3, Jan. 20, 1922, pp. 91–92, 1 fig. Discusses the problem of deceleration and considers brake power in relation to increased weight and speed of trains, combined with reduced headway. Summary of paper read before Instn. Civil Engrs.

RAILWAY REPAIR SHOPS

Freight-Car. Community Hospitals for Disabled Foreign Freight Cars, J. J. Tatum. Ry. Rev., vol. 70, no. 3, Jan. 21, 1922, pp. 73–76, 2 figs. Advocates adequate car facilities at important interchange points on cooperative basis.

RAILWAY SHOPS

Electric Drive for. Electric Drives in Railroad Shops, Bertram S. Pero. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 477–481, 10 figs. Selection and types of motors, and application on different kinds of machine tools.

RAILWAY SIGNALING

Interlocking. Interlocking Practice of the Interborough Rapid Transit Ry., W. A. Bartley. Ry. Rev., vol. 70, no. 4, Jan. 28, 1922, pp. 113–115. Describes electropneumatic power interlocking plant and their equipment, traffic density and control, etc. From paper read before N. Y. Sectional Committee.

Light. The Light Signal Committee's Report. Ry. Gaz., vol. 36, no. 3, Jan. 20, 1922, pp. 80–81. Discusses report of departmental committee to Ministry of Transport, who have been inquiring into the potentialities of light signals. Committee favors color light as against position light.

Track Circuits. Testing of D. C. Track Circuits to Insure Safety and Efficiency, F. B. Weigel. Ry. Signal Engr., vol. 15, no. 1, Jan. 1922, pp. 7–9, 2 figs. Discusses limiting resistance at battery; bonding wires; track ballast; track relay and housing. Simple tests should be made periodically. Paper read before A. R. A.

RAILWAY STATIONS

Freight. On the Question of Goods (Freight) Stations, Edilio Ehrenfreund. Int. Ry. Assn. Bul., vol. 4, no. 1, Jan. 1922, pp. 5–24, 11 figs. Report No. 2 (Italy). Organization of receiving and delivering stations, so as to accelerate their business. Arrangement of building and tracks so as to simplify shunting (switching) operations and handling. Mechanical appliances.

On the Question of Good (Freight) Stations, M. Jullien and M. Moutier. Int. Ry. Assn. Bul., vol. 4, no. 1, Jan. 1922, pp. 151–192, 12 figs. Report No. 1 (All countries, except Italy and those using English language.) Organization of receiving and delivering stations, so as to accelerate their business. Arrangement of buildings and tracks so as to simplify shunting (switching) operations and handling, particularly as regards goods in bulk. Mechanical appliances.

RAILWAY TIES

Specifications. Procurement of Railway Ties Under Federal Control, G. G. Yeomans. Ry. Rev., vol. 70, nos. 1 and 2, Jan. 7 and 14, 1922, pp. 20–22 and 55–57. Work of the Forest Products Section. Standard tie specification most notable achievement. Describes control and distribution of all wood preservatives, together with work involved in procurement of lumber required for construction of Railroad Administration freight cars.

Treatment. Wood Preservers Discuss Economics of Ties. Ry. Age, vol. 72, no. 4, Jan. 28, 1922, pp. 269–271, 1 fig. Factors affecting cost of treated cross ties. Economics of tie renewals. Papers read before Am. Wood-Preservers' Assn.

RAILWAY TRACK

Maintenance. On the Question of the Maintenance and Supervision of the Track, Joseph Barbierint. Int. Ry. Assn. Bul., vol. 4, no. 1, Jan. 1922, pp. 139–150. Report No. 4 (All countries, except Great Britain and America.) Measures to be taken to provide an economic organization for maintenance and supervision of track, taking into consideration increase of traffic and speed as well as rise in wages and in cost of materials. Use of mechanical appliances.

Relocation. Costly Railroad Re-location. Cement & Eng. News, vol. 34, no. 2, Feb. 1922, pp. 23–24, 2 figs. Shifting 15 miles of double-track railroad around Huffmann dam, Miami Conservancy District, required excavating 657,000 yd., mostly rock in one cut 120 ft. deep, placing 390,000 yd. embankment. Cost more than $3,237,000.

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Relocation on the South African Government Railways. Eng. News-Rec., vol. 88, no. 3, Jan. 19, 1922, pp. 116–118, 4 figs. A 70-mi. relocation in rough country, reducing curvature 50 per cent and maximum grades from 3.3 to 1.5 per cent, is being carried out on S. A. Government Railways to meet requirements of increasing traffic.

Roadbed Construction. On the Question of the Construction of the Road Bed and of the Track. M. Henry and M. Candelier. Int. Ry. Assn. Bul., vol. 4, no. 1, Jan. 1922, pp. 251–270, 11 figs. Supp. to Report No. 2 (Oct. 1920, p. 639) (All countries, except Denmark, Sweden, Norway, Great Britain and America.) Arrangements to be adopted, in view of increase in locomotive weight and speed of trains.

RAILWAY YARDS

Terminals and. Report of Committee XIV—On Yard and Terminals. Am. Ry. Eng. Assn. Bul., vol. 23, no. 239, Sept. 1921, pp. 65–84. Warehouses in connection with L. C. L. freight houses. Classification yards, including methods of switching from classification to departure yards.

RAILWAYS

Light. Development of Light Railways in Great Britain. Eng. News-Rec., vol. 88, no. 5, Feb. 2, 1922, p. 205. Standard gage preferable; or 30-in. for isolated lines. Light rail and load; economic operation; road motors.

Net Cost of Transportation. On the Question of the Net Cost, Rates, Samuel O. Dunn. Int. Ry. Assn. Bul., vol. 4, no. 1, Jan. 1922, pp. 123–138. Report No. 3 (America). Determination of net cost of carriage (passengers and goods), taking capital charges into consideration. Relation to rates charged.

REFRIGERATING MACHINES

Modern Types. The Present Status of Design of Refrigerating Machines (Der heutige Stand des Kältemaschinenbaues), Martin Krause. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 52, Dec. 24, 1921, pp. 1349–1355, 25 figs. Notes on working process of superheated compressor in ammonia machines. Present design of compressors and condensers. Improvement of carbonic-acid machines using hot cooling water by increasing liquid pressure. Steam refrigerating machines for low brine temperatures and high refrigerating capacities.

REFRIGERATING PLANTS

Ammonia Condensers. Types and Constructions of Ammonia Condensers. Power, vol. 55, no. 6, Feb. 7, 1922, pp. 208–210, 7 figs. Discusses principles of operation of several condensers in general use.

Economy in. Refrigerating Plant Economy Standards and Records, Victor J. Azbe. Ice & Refrigeration, vol. 62, no. 1, Jan. 1922, pp. 19–21. Discusses basic requirements of an efficient plant, including, lowest possible condenser pressure and highest possible back pressure, highest possible CO_2 and lowest possible flue-gas temperature, etc. Paper read before Nat. Assn. Practical Refrig. Engrs.

REFRIGERATION

Carbonic-Dioxide Refrigerating Cycle. The Carbonic Refrigerating Cycle, H. J. Macintire. Power, vol. 55, no. 5, Jan. 31, 1922, pp. 175–177, 2 figs. Presents latest table on properties of saturated carbon dioxide, which is said to be great improvement over previous tables, and diagram known as total-heat diagram, showing effect of condensation or liquefaction of carbon dioxide and condition of substance.

Forecooling Liquid Ammonia. Forecooling of Liquid Ammonia, H. T. Whyte. Ice & Refrigeration, vol. 62, no. 1, Jan. 1922, p. 15. Discusses different methods. Paper read before Nat. Assn. Practical Refrig. Engrs.

Wet vs. Dry Compression. Wet vs. Dry Compression, Van. R. H. Greene. Ice & Refrigeration, vol. 62, no. 1, Jan. 1922, pp. 10–11. Objection to wet compression; maximum output for minimum of power; etc. Paper read before Nat. Assn. Practical Refrig. Engrs.

RIVETING

High-Speed Hammers. Cutting Costs with Riveting Hammers, Fred R. Daniels. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 474–476, 6 figs. Several examples of cold-heading and rivet-setting operations performed on high-speed riveting hammers made by the High Speed Hammer Co., Inc., Rochester, N. Y., are illustrated.

ROLLING MILLS

Cross. Cross-Rolling Mills. Eng. Progress, vol. 3, no. 1, Jan. 1922, pp. 4–6, 12 figs. Discusses mode of action and field of application, and describes the Friemel cross-rolling mill.

Sheet Mills. Sheet Mill of the Otis Steel Company. Iron Age, vol. 109, no. 4, Jan. 26, 1922, pp. 259–263, 6 figs. Features include staggered arrangement of furnaces. Powdered coal used. Plant notable for its applications of modern equipment and design.

Strip-Rolling Calculations. Cold Rolled Strip Steel Calculations, S. T. Hilliard. Iron Age, vol. 109, no. 4, Jan. 26, 1922, pp. 267–268. Formulas for determining pounds output and piece-work rates in manufacture of cold-rolled strip steel.

RUBBER

Energy-Absorbing Capacity. Energy Absorbing Capacity of Vulcanized Rubber, H. P. Gurney and C. H. Tavener. Jl. Indus. & Eng. Chem., vol. 14, no. 2, Feb. 1922, pp. 134–139, 36 figs. Discusses relations which exist between capacity of vulcanized rubber to absorb or store up in a potential form and partially to transform or degrade kinetic energy into heat when subjected to single or repeatedly applied stresses.

S

SAND, MOLDING

Origin and Uses. Moulding Sands: Their Origin and Uses, Alexander Scott. Mech. World, vol. 71, no. 1830, Jan. 27, 1922, pp. 71–72. Discusses uses of sands as abrasives, for casting molds and surface linings, building purposes, an ingredient of soap, and as a filtering medium in connection with water supplies. From paper read before Stoke Assn. of Engrs.

SCALES

Precision Tests. The Precision Test of Large Capacity Scales. Scale Jl., vol. 8, no. 1, Jan. 10, 1922, p. 6, 1 fig. Gives extract from Technologic Paper 199 of Bur. of Standards, which outlines procedure for accurate test.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCRAP

Non-Ferrous, Smelting. The Smelting of Scrap Metal (Einschmelzen von Metallabfällen), F. Reinboth. Metall-Technik, vol. 47, no. 4, Mar. 9, 1921, pp. 21–23. Suggestions for smelting of aluminum, copper, brass, nickel, zinc and rare-metal scrap.

SEAPLANES

Fairey Long-Distance. The New Fairey Long-Distance Seaplane. Flight, vol. 14, no. 3, Jan. 19, 1922, pp. 35–36, 3 figs. Top speed developed was 95 m.p.h. with a power load of over 19 lb. per hp., and a wing loading of over 10 lb. per sq. ft. Rolls-Royce "Eagle" engine.

SEMI-DIESEL ENGINES

Peugeot. The Peugeot Semi-Diesel Engine. Motor Transport, vol. 34, no. 882, Jan. 23, 1922, pp. 99–102, 12 figs. Describes two-cylinder two-stroke motor of original design which is being put into service in Paris by General Omnibus Co.

Vickers-Petter Manufacturing Methods. Semi-Diesel Engine Construction. Eng. Production, vol. 7, nos. 66 and 67, Jan. 5 and 12, 1922, pp. 13–19 and 37–41, 29 figs. Describes works practice of Vickers-Petters, Ltd.

SEMI-STEEL

Elongation and Compression. Elastic Limits of Elongation and Compression of Semi-Steel (Limites élastiques a la Traction et a la Compression de la Fonte aciérée), M. Portevin. Fonderie Moderne, no. 11, Nov. 1921, pp. 321–324, 5 figs. Gives results of tests from which curves are plotted and formula developed.

SHAPERS

Vertical. Production Work on Vertical Shapers, Edward K. Hammond. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 483–485, 5 figs. Operations advantageously performed on shapers of vertical type.

SILICA BRICK

Breakage Factor in Manufacture. Breakage Factors in Silica Brick Manufacture, Philip H. Jung. Chem. & Met. Eng., vol. 25, no. 5, Feb. 1, 1922, pp. 214–217. Critical discussion of those factors in manufacture of silica brick which determine breakage records; properties of silica rock; grinding; effect of bats; workmanship; drying; setting in kiln; burning; methods of firing.

South Wales Silica. The Refractory Silica Materials of South Wales, W. R. D. Jones. Colliery Guardian, vol. 123, no. 3184, Jan. 6, 1922, p. 41. Discusses importance of texture and correct grading of materials employed in silica brick manufacture; also refractoriness.

SPRINGS

Helical, Calculation of. Practical Helical Spring Calculation, Alex Taub. Am. Mach., vol. 56, no. 5, Feb. 2, 1922, pp. 179–183, 2 figs. Essentials of spring design. Analyzing spring troubles mathematically.

STANDARDIZATION

Basic Standards. Development and Construction of Standard Parts Making Use of Basic Standards (Entwicklung und Aufbau von Normteilen unter Benutzung von Grundnormen), R. Koch. Betrieb, vol. 4, no. 7, Jan. 14, 1922, pp. 83–89, 21 figs. It is shown on two definitely established standard parts that even the simplest standard part is composed of different individual standards; and on screwed pipe joints and plug cocks that a systematic development of suitable basic standards is of great advantage in standardization. Report of German Industry Committee on Standards (NDI).

Germany. Industrial Standardization in Germany. Mech. Eng., vol. 44, no. 2, Feb. 1922, pp. 136–137. Describes program being carried out in Germany. Organization and methods of work; work in special industries; system of "preferred numbers."

Importance. Significance of Standardization, A. A. Stevenson. Am. Mach., vol. 56, no. 4, Jan. 26, 1922, pp. 138–139. Points out need for coöperation between industry and Federal Government. Work of committees in harmonizing conflicting standards and formulating new ones. (Abstract.) Paper presented before Am. Eng. Standards Committee.

STANDARDS

German N. D. I. Report. Report of the German Industry Committee on Standards (Normenausschuss der Deutschen Industrie). Betrieb, vol. 4, no. 6, Dec. 24, 1921, pp. 73–77, 4 figs. Proposed standards for fastening of belt pulleys on transmission shafts, and for ball hand cranks. Problems of the working committee for screws.

STEAM

Generation and Utilization. Fuel Economy by the Adoption of Scientific Management in Steam Generation and Utilisation, David Brownlie. Eng. & Indus. Management, vol. 7, nos. 2, 4 and 5, Jan. 12, 26 and Feb. 2, 1922, pp. 39–41, 6 figs., 117–120, 9 figs. and 131–132, 2 figs. Jan. 12: Boiler and pipe coverings. Jan. 26 and Feb. 2: Steam traps.

STEAM ENGINES

Compound Drop-Valve. Compound Drop-Valve Mill Engine. Mech. World, vol. 71, no. 1827, Jan. 6, 1922, pp. 11–12, 3 figs. Describes cross-compound jet-condensing type of engine, having cylinders 27 in. and 55 in., with a 5-ft. stroke, built by Hick, Hargreaves & Co., Bolton. Develops 1580 i.hp. at 65 r.p.m.; boiler pressure, 160 lb.

Schmidt High-Pressure. Schmidt Steam Engine More Efficient Than Largest Turbine, O. H. Hartman. Power, vol. 55, no. 6, Feb. 7, 1922, pp. 217–219, 2 figs. Results of tests indicate that it is feasible to generate and utilize steam at pressure of 800 lb. per sq. in. and over in reciprocating engines with probable gain of 20 per cent in efficiency as compared to best present-day turbine practice. Steam consumption of 5.12 lb. per i.hp. was obtained with 150-hp. engine. Translated from Zeit. des Vereines deutscher Ingenieure.

Uniflow. Modern Development of Uniflow Steam Engines (Die neuere Entwicklung der Gleichstromdampfmaschine), H. Bonin. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 46, Nov. 18, 1921, pp. 372–374, 4 figs. Describes various working losses occurring in a reciprocating steam engine and shows how these losses can be greatly reduced in a uniflow engine. Report of new edition of [illegible] Uniflow Steam Engines, by J. Stumpf.

300-HP. Uniflow Engine. Engineering, vol. [illegible], no. 2927, Feb. 3, 1922, p. 136, 7 figs. [illegible] Describes engine recently constructed [illegible] Davidson's patents by Clayton, Goodfellow & Co., Ltd., Blackburn, England. It has a single cylinder 24-in. diam. by 30-in. stroke, and operates with steam at 160 lb. per sq. in. and 150 deg. fahr. superheat.

STEAM METERS

Kent-Hodgson. The Kent-Hodgson Steam Meter, J. L. Hodgson. So. African Eng., vol. 2, no. 12, Dec. 31, 1921, pp. 243–245, 5 figs. Describes steam meter developed by the author and his firm, Kent, Ltd., Lond.). Used in power stations, [illegible] paper mills, collieries and cement works, [illegible] and pumping stations, on locomotives and [illegible] board.

STEAM PIPES

Economical Diameter. The Most Economical Pipe Diameter for Steam Piping (Der billigste Rohrdurchmesser fur Kraftdampfleitungen), O. Dencker. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 49, Dec. 9, 1921, pp. 394–396, 1 fig. Determination of diameter taking only pipe friction into consideration; and taking the separate resistance into consideration; the cheapest diameters. Numerical example with high-pressure saturated steam [illegible].

STEAM POWER PLANTS

Auxiliary Drives. Driving Power-House Auxiliaries, W. H. Smith. Power, vol. 55, no. 5, Jan. 31, 1922, pp. 166–169, 3 figs. Types of auxiliary drives; head balance considerations that influence selection of drives; a.c. versus d.c. motors; suitability of motors for auxiliary motors; selection of motors for various drives.

Birmingham, Ala. Sloss Sheffield Steel and Iron Company's Steam Generating Station, M. M. Vago and H. Maulshagen. Blast Furnace & Steel Plant, vol. 10, no. 1, Jan. 1922, pp. 83–88, 14 figs. Describes their modern steam-generating plant, North Birmingham, Ala., including [illegible] tem and by-product power house.

STEAM TURBINES

Blade Proportioning. The Proportioning of Steam Turbine Blading, Harold Medway Martin. Engineering, vol. 113, nos. 2923, 2924, 2925, 2926, 2927, Jan. 6, 13, 20, 27 and Feb. 3, 1922, pp. 1–4, 33–34, 66–70, 96–98 and 128–130, 14 figs. Determination of effective thermodynamic head and general dimensions of a compound turbine to operate with given indicated hydraulic efficiency; also relation between thermodynamic head and specific volume.

Increasing Efficiency. Possibilities of the Turbine, P. F. Coffin. Power, vol. 55, no. 4, Jan. 24, 1922, pp. 136–137, 1 fig. Points out that efficiency limitations reached in steam turbines may be overcome by using two vapors in series, such as mercury and steam. A 1000-kw. experimental unit has operated under conditions equivalent to producing 1 kw-hr. on about 11,300 B.t.u. (Abstract.) Author's contribution, "Utilization of Coal on a Multiple-Products Basis," to R. F. Bacon's and W. A. Hamor's forthcoming book, "American Fuels."

STEEL

Alloy. See ALLOY STEELS.

Boiler-Tube. Occurrence of Oxides and Nitrides in Boiler Tube Steel, A. E. White and J. S. Vanick. Am. Soc. for Steel Treating Trans., vol. 2, no. 4, Jan. 1922, pp. 323–330, 8 figs. Discusses examination of boiler tube which has been overoxidized, or allowed to absorb and retain an excess of oxygen and nitrogen.

Casting Ingots. Leaves from a Steel Melter's Note Book, Henry D. Hibbard. Iron Age, vol. 109, no. 7, Feb. 16, 1922, pp. 465–467. Experiences in casting

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